SCIENCE AND SITUATED KNOWLEDGE: COFFEE GROWERS AND ADAPTATION STRATEGIES FOR CLIMATE CHANGE IN SOUTH INDIA

Thesis submitted to the Jawaharlal Nehru University
in partial fulfilment of the requirements for the award of the degree of

DOCTOR OF PHILOSOPHY

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CERTIFICATE

This is to certify that the thesis entitled **Science and Situated Knowledge: Coffee Growers and Adaptation Strategies for Climate Change in South India** submitted by **Anshu Ogra** to the Centre for Studies in Science Policy, School of Social Sciences, Jawaharlal Nehru University, New Delhi-110067, India, in partial fulfillment of the requirements for the award of the degree of **Doctor of Philosophy** of this University is her original work and has not been submitted so far, in part or in full, for any other degree or diploma, in this or any other university or institution.

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Dated: 12 July 2017

DECLARATION

This is to certify that the thesis entitled **Science and Situated Knowledge: Coffee Growers and Adaptation Strategies for Climate Change in South India** submitted by me in partial fulfillment of the requirements for the award of the degree of **Doctor of Philosophy** is my own original work and has not been submitted previously, in part or in full, for any other degree or diploma in this or any other university or institution.

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For Mumma

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Abbreviations

AICI or AIC: Agriculture Insurance Company of India
ARG: Automatic Rain Gauge
AR5: Assessment Report 5
ATREE: Ashoka Trust for Research on Ecology and Environment
AWS: Automatic Weather Station
BGL: Black Gold League
CAP: Cancun Adaptation Plan
CCRI: Central Coffee Research Institute
CDF: Coffee Demonstration Farm
C-MMACS: Center for Mathematical Modeling and Computer Simulation
COP: Conference of Parties
CO_2: Carbon-di-oxide
CPR: Centre for Policy Research
CSM: Centre for Social Markets
CSIR: Council of Scientific and Industrial Research
CSTEP: Centre for Study of Science, Technology and Policy
DMC: Drought Management Centre
GBM: General Body Meeting
GCM: Global Circulation Models
GHGs: Green House Gases
GFS: Global Forecasting System
G.I.pipes: Galvinized Iron Pipes
HDPA: Hassan District Planters Association
hPa: Hectopascal
IBWI: Index Based Weather Insurance
ICICI: Industrial Credit and Investment Corporation of India
ICO: International Coffee Organization
ICTA: Indian Coffee Traders Association
IITM: Indian Institute of Tropical Management
IIPM: Indian Institute of Plantation Management
IIT: Indian Institute of Technology
IMD: Indian Meteorology Department
INCCA: Indian Network on Climate Change Assessment
IPCC: Intergovernmental Panel on Climate Change
ISS: International Space Station
KSRTC: Karnataka State Road Transport Corporation
KSNDMC: Karnataka State Natural Disaster Management Cell
KGF: Karnataka Growers' Federation
Kg: Kilogram
KPA: Karnataka Planters' Association
LDC: Least Developed Countries
LPD: Leak Prevention Devices
MAE: Mean Absolute Error
MoEFCC: Ministry of Agriculture Forest and Climate Change
MSLP: Mean Sea Level Pressure

NAPA: National Adaptation Programme of Action
NAL: National Aerospace Laboratories
NASA: National Aeronautics and Space Administration
NCAP: National Centre for Agriculture and Economic Policy
NCMSL: National Collateral Management Services
NCMRWF: National Centre for Medium Range Weather Forecasting
NGO: Non-Governmental Organization
NWP: Numerical Weather Prediction
OECD: Organization for Economics Co-operation and Development
pH: potential of Hydrogen
PHCC: Palini Hills Conservation Council
PPM: Parts per million
RF: Rainfall
RRG: Reference Rain Gauge
RISC: Rainfall Insurance Scheme for Coffee
SAE: Sum of Absolute Error
SAPCC: State Action Plan on Climate Change
SBSTA: Subsidiary Body for Scientific and Technological Advice
STS: Science technology Studies
TRG: Telemetric Rain Gauge
TWS: Telemetric Weather Station
UKCIP : United Kingdom Climate Impacts Program
UNEP: United Nations Environment Programme
UNFCCC: United Nations Framework Convention on Climate Change
UNDP: United Nation Development Programme
UPASI: United Planters Association of South India
VHRR: Very High Resolution Radiometer
WBCIS: Weather Based Crop Insurance Scheme
WCPC: Women Coffee Promotion Council
WG I: Working Group I
WG II: Working Group II
WG III: Working Group III
WMO: World Meteorological Organization
WRF: Weather Research and Forecasting
WSB: White Stem Borer

Chapter 1

Introduction

This PhD effort engages with the field of Science Technology Studies and takes up the challenge spelled out by Sheila Jasanoff, who urges us to meaningfully understand how 'global facts' about climate change contend with 'local values'.[1] This PhD thesis discusses three different perceptions over the 'meaning' of rainfall with regard to coffee production in the Western Ghats region in South India. The three perceptions that I refer to and discuss are those framed by: a) coffee growers b) meteorologists and c) insurers.

It is being increasingly argued, notably in several recent academic publications, that though there is a need to understand the global dimensions of climate change, it can nonetheless be only meaningfully grasped in locally specific and situated contexts. Mike Hulme, amongst the most insightful voices on the subject, argues that climate change should be conceptualized as a situated phenomenon borne out of relationships between people and places, rather than being a 'purified', de-contextualized system of abstract knowledge.[2] Sheila Jasanoff similarly urges us to go beyond the impersonal scientific framings of climate change and instead take on board the analyses of the 'mundane rhythm of lived lives' and 'everyday experience'.[3]

The conceptual chasm of sorts between the global fact and the local value, however, is most intensely revealed in the attempts at evolving climate change adaptation strategies. In particular, the acute realization that climate science ─ given its penchant for modeling and abstractions ─ do not necessarily capture the impacts from fine grained weather complexity on the ground. In effect, formulating credible climate change adaptation strategies requires us to study and rigorously understand the many points and

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[1] Sheila Jasanoff. (2010). A New Climate for Society. *Theory, Culture & Society* 27(2-3):236

[2] Mike Hulme. (2008). Geographical work at the boundaries of climate change. *Transactions of the Institute of British Geographers* 33(1): 5-11.

[3] Sheila Jasanoff. (2010). A New Climate for Society. 236.

conceptual overlaps between modelers and experiences of everyday life.[4,5,6,7,8] There are three main objectives of this study: a) How is the understanding of a weather event experienced in a situated context? b) How are climate change impacts as global facts conceptually different from weather variation at the local level? and c) How to formulate climate change adaptation strategies when local values afford different weather experiences than the statistically patterned and scientifically measured data.

Adaptation to climate change: Science Technology Studies (STS) perspectives

Article 1 of the United Nations Framework Convention on Climate Change (UNFCCC, 1992) defines climate change as: 'a change in climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods'.[9] UNFCCC thus makes a distinction between climate change that can be attributable to human activities which alter the atmospheric composition and climate variability produced by natural causes. The Intergovernmental Panel on Climate Change

[4] Nico Stehr & Hans Von Storch. (1995). The social construct of climate and climate change. *Climate Research* 5(2): 99-105.

[5] Catherine Brace & Hilary Geoghegan. (2011). Human geographies of climate change: Landscape, temporality, and lay knowledges. *Progress in Human Geography* 35(3): 284-302.

[6] B. Behera & R. Vaswan. (2008). Understanding the relationship between global and local commons: A study of household perceptions of climate change in Leh, Ladakh. *Governing Shared Resources: Connecting local experience to global challenges. IASC conference proceedings*, University of Gloucestershire, Cheltenham, UK.

[7] Ilan Kelman, Jessica Mercer & Jennifer J. West. (2009).Combining different knowledges: community-based climate change. *Community-based Adaptation to Climate Change* 60 (2009): 41.

[8] Jessica Mercer, Ilan Kelman., et.al. (2010).Framework for integrating indigenous and scientific knowledge for disaster risk reduction in Papua New Guinea. *Geografiska Annaler: Series B, Human Geography* 91(2): 157-183.

[9] United Nations.(1992). United Nations Framework Convention on Climate Change (UNFCCC). Article1.p.7. https://unfccc.int/files/essential_background/background_publications_htmlpdf/application/pdf/conveng.pdf (3/11/2016).

(IPCC), in fact, takes note of this distinction.[10] The Fifth Assessment Report of the IPCC published in 2014 states that 'anthropogenic drivers have been detected throughout the climate system and are *extremely likely* to have been the dominant cause of the observed warming since the mid-20th-century.'[11] In the language of the IPCC the *extremely likely* refers to a likelihood of over 95%.

The alteration in global atmosphere specifically refers to the increase in greenhouse gases (GHGs) like carbon-di-oxide, methane and water vapor.[12] Concentration of these gases regulate global temperatures and therefore any increase in their concentration in the atmosphere would cause impacts on geophysical systems

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[10] In 1988, United Nations Environment Programme (UNEP) and World Meteorological Organization (WMO) jointly established the Intergovernmental Panel on Climate Change (IPCC) as concern over changes in the climate gained momentum. The purpose of the IPCC was to assess the state of knowledge on the various aspects of climate change including science, environment and socio-economic impacts and response strategies. The IPCC work is shared among three Working Groups.

IPCC Working Group I (WGI) assesses the physical scientific aspects of the climate system and climate change. IPCC Working Group II (WGII) assesses the vulnerability of socio-economic and natural systems to climate change, negative and positive consequences of climate change, and options for adapting to it. IPCC Working Group III (WGIII) assesses options for mitigating climate change through limiting or preventing greenhouse gas emissions and enhancing activities that remove them from the atmosphere. IPCC is recognized as the most authoritative scientific and technical voice on these issues, and its assessments has a profound influence on the negotiators of the United Nations Framework Convention, UNFCCC. UNFCCC came into being in 1992, countries joined this international treaty to cooperatively consider what they could do to limit average global temperature increases and the resulting climate change, and to cope with whatever impacts were, by then, inevitable.

[11]IPCC.(2014).Climate Change 2014: Synthesis Report. Contributions of Working Groups I, II and III to the Fifth Assessment Report of Intergovernmental Panel on Climate Change (core writing team R.K.Pachuri and L.A. Meyers (eds.)) IPCC, Geneva, Switzerland p. 4. https://www.ipcc.ch/pdf/assessmentreport/ar5/syr/AR5_SYR_FINAL_SPM.pdf (7/11/2016).

[12] Greenhouse gasses are those that absorb and emit infrared radiation reflected back from earth surface. Most abundant greenhouse gasses in Earth's atmosphere are: water vapor, carbon dioxide, methane, nitrous oxide, ozone, chlorofluorocarbons and hydrofluorocarbons.

including aggravating floods, droughts, sea level rise and the increased incidences of other related extreme weather events.[13]

Arguably, for some, the study of climate change involves carefully walking the precarious line between the certitudes of verified and testable scientific facts and their opposite — the rule-of-thumb opinions borne out of subjective experiences or perceptions on the ground. Clearly, one of the alternative routes to taking up such a challenge is to turn this less than firm conceptual boundary between the hard sciences and the social sciences into a site instead for productive conceptual rethinking and theoretical reflection.[14,15] For D. Guston, the field of STS, in fact, offers the most creative possibilities for reworking such boundary conditions, which, while striving to maintain the scientific integrity of climate change knowledge (generated by IPCC), can also seek to credibly incorporate aspects of situated local experiences.[16]

It is argued that at a time when society is asking for policy solutions for addressing climate change challenges it is important that science is called upon to do more than answer the seemingly obvious: is the world getting hotter? This need to rethink the grounds for a solely scientific framing of the climate change issue has been argued by Daniel Sarewitz and Roger Pielke Jr. According to them the terms of debate around climate change discussions have overwhelmingly tended to be reduced to a single

[13] IPCC.(2014). Summary for policymakers. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L.White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 5.
https://www.ipcc.ch/pdf/assessment-report/ar5/wg2/ar5_wgII_spm_en.pdf (4/11/2016)

[14] S.O. Funtowicz & J. Ravetz.(1993).Science for the Post-Normal Age. *Futures* 25(7): 739–55.

[15] Alan Irwin & Mike Michael.(2003). *Science, Social Theory and Public Knowledge*. Maidenhead, U.K.: Open University Press.

[16]D.Guston.(2001).Boundary organizations in environmental policy and Science: An introduction. *Science, Technology & Human Values* 26(4): 399-408.

question — does the carbon-dioxide emitted by industrial societies threaten earth's climate?[17]

Sheila Jassanoff cautioned against the implication that 'climate change exists because of science', which wrongly suggests that scientists have constructed our understanding of climate change in some sort of a fictional sense. Rather, as Jassanoff clarifies, the disciplinary apprehensions within the social sciences about climate change discussions lies in the fact that the latter's conceptual approaches cannot always speak to only science based framings.[18] In actual fact, however, concerns about climate change, according to Jassanoff, cuts against the very 'grain of ordinary human experience' at four interrelated levels: communal, political, spatial and temporal.[19] Thus, for Jasanoff, there is urgency in calling for a rethink in the representations of climate change debates by going beyond only its impersonal scientific framings. The need, she argues, is to focus on the lived everyday lives.[20]

In this study we focus on adaptation strategies. Adaptation is one of the two strategies available to address climate change. The other one is mitigation. Mitigation refers to efforts aimed at reducing or preventing greenhouse gas emissions, while adaptation refers to the adjustments that societies make to limit the negative effects or to take advantage of opportunities provided by a changing climate.[21] In the climate change

[17]Daniel Sarewitz and Roger Pielke Jr. (July 2000). Breaking the global- Warming Gridlock. *The Atlantic Monthly*. http://www.theatlantic.com/magazine/archive/2000/07/breaking-the-global-warming-gridlock/4973/ (accessed on 22 June 2012).

[18] Jasanoff. (2010). A New Climate for Society. p. 236.

[19]Ibid.,p. 237.

[20]Ibid.,p. 238.

[21] IPCC Climate Change (2014), Impacts, Adaptation, and Vulnerability. *Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. USA Cambridge University Press*.

literature, numerous definitions have been proposed for adaptation.[22, 23] Based on timing of the action relative to climate stimuli, adaptations may be reactive (or responsive or ex post), concurrent or anticipatory (proactive).[24] For a considerable period, nonetheless, in climate change discussions, the idea of adaptation was often viewed as simply being a poor cousin to the more decisive interventions by mitigation strategies.[25,26] Having been thus framed, in earlier years under the shadow of mitigation, there was a tendency to limit the idea of adaptation to merely addressing the impacts from localized weather events.[27]

Increasingly, however, in recent years a sense of urgency, purpose and deliberateness is being attached, especially at the policy level, to the many possibilities that adaptation holds for responding to climate change challenges. But as Lesley Head points out, these expectations sit uneasily with existing conceptualization of climate change adaptation.[28] It needs to be flagged here that adaptation is not a new word. Earlier writings in ecology and geography have extensively discussed the notion of adaptation. In such a context, adaptation is defined as the process by which an animal or plant

[22] J.Smithers & B.Smit.(1997).Human adaptation to climatic variability and change. *Global Environmental Change* 7(2): 129-146.

[23] W.N.Adger., S.Huq., et.al.(2003). Adaptation to climate change in the developing world. *Progress in development studies* 3(3): 179-195.

[24] B. Smith., I. Burton., et.al. (2000). An anatomy of adaptation to climate change and variability. *Climatic Change* 45(1): 223-251.

[25] Roger Pielke Jr., Gwyn Prins., et.al. (2007). Lifting the Taboo on Adaptation. *Nature* 445: 597-598.

[26] Robert G Biesbroek.., Swart, Rob J., et.al. (2009). The Mitigation-Adaptation Dichotomy and the Role of Spatial Planning. *Habitat International* (33): 230-237.

[27] Jon Barnett. (2001). Adapting to Climate Change in Pacific Island Countries: The problems of uncertainty. *World Development* (29): 977-93.

[28] Lesley Head. (2010). Cultural ecology: adaptation-retrofitting a concept? *Progress in Human Geography* 34(2): 234-242.

species can be ‘fitted’ to its environment.[29] Commenting on this transition of adaption from the field of ecology to the field of policy making, Bassett and Fogelmen argue that the Intergovernmental Panel on Climate Change (IPCC), which is the most authoritative voice on the matter, ‘operates with a pedestrian and in many respects old-fashioned notion of adaption as adjustment to climate stimuli’.[30]

The uneasy transition of adaptation is particularly telling in terms of the unique challenges posed by climate change. Why is adaptation as a concept from evolutionary biology out of tune with anthropogenic climate change? Put differently, what is particularly unique about anthropogenic climate change as an environmental problem that unsettles our understanding of the humans as biological beings? Hashtrup argues that the figure of ‘climate’ in climate change discussions emerges from an unprecedented entanglement of natural and social processes.[31]

That is to state that it is no longer possible to understand the earth system as being independent of human influence. The earth system is so deeply marked by human activity that climate cannot be understood without acknowledging that humans are all over the place, not only as destroyers of nature, of course, but also as providers of solutions.[32] Thus there is a need to rethink adaptation in the background of this agency that humans have come to acquire, an agency which is exercised through everyday decision making on the ground.[33]

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[29] Harold Brookfield. (1973). Introduction: explaining or understating? The study of adaptation and change in *The Pacific in Transition: Geographical perspectives on adaptation and change*. (ed) H. Brookfield. Canberra: ANU Press: 3-24.

[30] T. Basset and Fogelman. (2012). Deja Vue or something new? The adaptation concept in climate change literature. *Geoforum* 48:42-53.

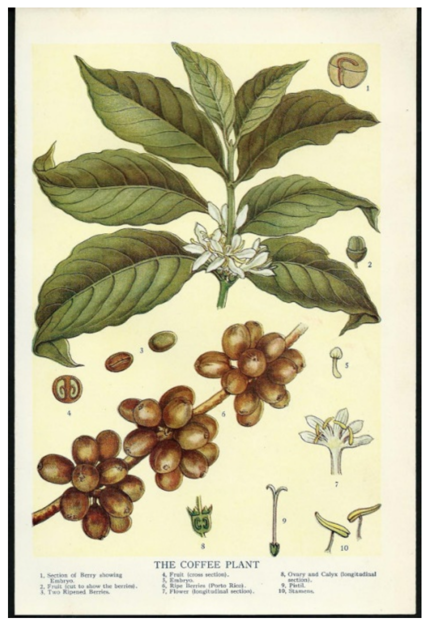
[31] Kristen Hashtrup.(2013). Anticipating Nature.*The Social Life of Climate Change Models* (eds.) Kristen Hashtrup and Martin Skrydstrup. Taylor and Francis. p.2.

[32] Ibid.,p.2.

[33] For more on the role of human agency in anthropocence see
Rohan D’Souza.(2015). Nations without Borders: Climate Security and the South in the Epoch of the Anthropocene, *Strategic Analysis* 39(6):720-728.

Coffee, Western Ghats and global climate change

This study focuses on weather variation and specifically rainfall variation in the coffee growing estates of South India. Coffee is extremely sensitive to weather conditions and is therefore correctly considered to be a highly unpredictable crop.[34,35] Weather is so crucial a factor that coffee traders, in fact, minutely monitor the weather conditions within the major coffee producing countries before making investment decisions. The specific conditions required for its growth are available only in sub-tropical region at an altitude of 1800-3600 feet and in tropical regions at an altitude of 3600-6300 feet. Even the slightest variation in the weather pattern leaves a mark and impact on the crop.[36]



Picture 1: Vintage 1920 botanical coffee plant illustration. Source:https://www.etsy.com/listing/154908993/vintage-coffee-bean-botanical (14/8/2016)

Botanically speaking, the coffee plant is a woody perennial evergreen plant that belongs to the *Rubiaceae* family. The two main species that are cultivated today are *Coffea arabica*, known as Arabica coffee, and *Coffea canephora*, known as Robusta coffee. Both these varieties are grown in India. However, the weather and geographical conditions required for cultivating these varieties are starkly different.

Arabica which traditionally fetches higher price than Robusta grows in cooler climate and at higher altitudes. The following table provides a brief overview of the physical

[34] J.N.Wintgens.(2009). *Coffee: growing, processing, sustainable production: a guidebook for growers, processors, traders and researchers.* Wiley-Vch.

[35] G. Wrigley.(1988). *Coffee. tropical agricultural series*. Long man Scientific and Technical publishing: New York: p. 639.

[36] B. Rodriguez & M. Vasquez.(2009). Economic aspects of coffee production in *Coffee: growing, processing, sustainable production. A guidebook for growers, processors, traders and researchers*: (ed.) J.N. Wintgen. Wiley-Vch.

conditions required to grow both these varieties.

Table 1: List of different physical conditions required for Arabica and Robusta plant to grow.

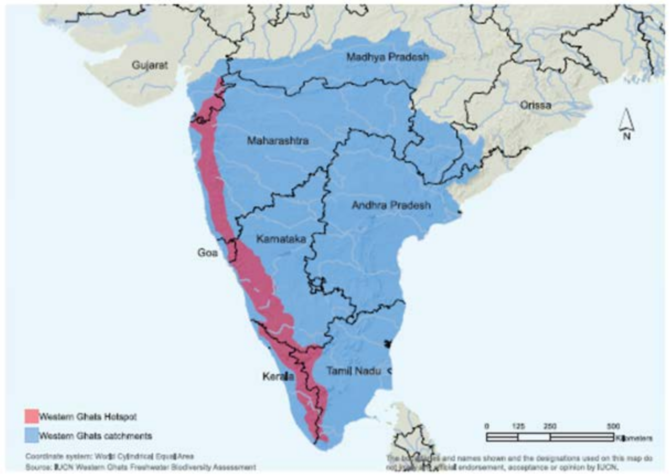
Factors	Arabica	Robusta
Soils	Deep, rich in organic matter, well drained, slightly acidic (pH 6-6.5)	Same as Arabica
Slopes	Gentle to moderate	Gentle to fairly leveled fields
Elevation	1000-1500 m	500-1000m
Aspect (It is the compass direction that a slope faces)	North, East and North-East aspects	Same as Arabica
Temperature	15^{o}c -25 ^{o}c, cool	20^{o}c – 30^{o}c, hot and humid
Relative Humidity	70-80%	80-90%
Annual Rainfall	1600-2500mm	1000-2000mm
Blossom Showers (first rainfall of the crop cycle)	March-April (25-40mm)	February –March (25-40mm)
Backing Showers (rains immediately following the blossoms shower).	April-May (50-75mm)	March-April (50-75mm)

Source: Introduction to Indian coffees, Coffee Board of India, http://www.indiacoffee.org/coffee-regions-india.html (21/1/2017).

Coffee is traditionally grown in three states in South India: Karnataka, Tamil Nadu and Kerala. 72.3% of total coffee production in India comes from Karnataka.[37] Within these states the required weather for growing coffee is available in the Western Ghats. The Western Ghats are a mountain range that runs parallel to the western coast of the Indian peninsula along the Arabian Sea. The mountains intercept the rain-bearing westerly monsoon winds, and are consequently an area of high rainfall particularly on the western side. The range starts from the Southern part of Gujarat and goes through Maharashtra, Goa, Karnataka and Kerala before it ends at Kanyakumari in Tamil Nadu.

[37] For data on coffee production please refer to annexure 14.

Map 1: Western Ghat belt in South India.



Source: http://westernghatflorafauna.blogspot.in/ (21/1/2017)

The Western Ghats are a major source of water for peninsular India. It is one of the world's eight biodiversity hotspots and a world heritage site.[38] A significant amount of research work has been carried out to study the impacts of climate change on the biodiversity rich ecosystem of Western Ghats. Most notable amongst them being the 4X4 Climate Assessment Report (4X4 Report for short), brought out in 2010 by Indian Network on Climate Change Assessment (INCCA), Ministry of Environment, Forests and Climate Change (MoEFCC), Government of India which assessed climate change impacts by 2030 on four ecologically sensitive sectors: the Himalayan region, Western Ghats, coastal areas and North-East regions of the country and four issues: agriculture, forests, human health and water together. The report prepared by INCCA argues that precipitation in Western Ghats region will be more intense with less rainy day and temperatures will see a gradual increase.[39] This argument was also shared in India's First

[38] Ashoka Trust for Research in Ecology and Environment (ATREE). *Western Ghats Clusters are UNESCO World Heritage Site*. http://atree.org/wg_unesco_whs_2012 (8/6/2017).

[39] INCCA. (2010). *Climate Change and India: A 4x4 Assessment, INCCA Report No. 2*. Indian Network for Climate Change Assessment (INCCA), Ministry of Environment and Forests, Government of India, New Delhi, November 2010.

and Second National Communications to the UNFCCC.,[40,41] Similar arguments have been made by scholars pursing independent studies.[42]

The distinguishing character of Indian coffee is that it is cultivated under shade. Shade traditionally refers to the original tree cover that is found in the Western Ghats.[43] Coffee estates inherently are a commercial enterprise that is driven by the profit motive across the globe.[44] While the Western Ghats provide the climatic conditions in which a coffee plant can be nurtured within its high hills and mountainous terrain the fragile ecosystem and biological diversity limits the extent to which coffee growers can shape and organize the estate as an ecosystem. A coffee estate in this region thus requires active engagement and continuous negotiations between coffee grower and local weather variation. A substantial amount of research work has, in fact, been carried out exploring the implications of climate change on coffee plants in India and other countries.[45,46,47,48,49,50] Coffee has also been studied for labor, commodity chain,

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[40] MoEFCC.(2004). India's Initial National Communications to the United Nations Framework Convention on Climate Change, Ministry of Environment and Forests, Government of India, New Delhi.

[41] MoEFCC. (2012). *India's Second National Communications to the United Nations Framework Convention on Climate Change*. Ministry of Environment and Forests, Government of India, New Delhi.

[42] S.N.Kumar., P.K. Aggarwal., S.Rani., S. Jain., R. Saxena & N. Chauhan. (2011). Impact of climate change on crop productivity in Western Chats, coastal and northeastern regions of India. *Current Science*. 101(3):332-341.

[43] Annexure 7 provides a detailed list of native trees found in coffee estates located in the Western Ghats belt.

[44] Uma Devi.(1989). *Plantation Economies of the Third World*. Bombay: Himalaya Publishing House.p. 3.

[45] P.G.Chengappa & C.M. Devika. (2016). Climate Variability Concerns for the Future of Coffee in India: An Exploratory Study. *International Journal for environment, Agriculture and Biotechnology* 1(4): 819-826.

biodiversity and consumption & health issues.[51,52,53,54] This work engages with coffee growing estates to study climate change and adaptation using STS perspective. The work thus carves a specific place for itself in the coffee and climate change literature.

It is important to flag here that my field work for this study is dominantly designed around one weather variable, rainfall. I remain, however, also sensitive to other weather variables such as temperature, relative humidity and length of the dry season that add up to shape weather perceptions amongst coffee growers. Rainfall, nonetheless, for two main reasons was chosen by me as being the primary weather variable to capture the growers' experience. These two reasons were: a) rainfall kick starts the coffee crop cycle and b) coffee growers maintain detailed rainfall records of their estates.

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[46] P. Vaast. (2011). CAFNET Final narrative report. ENV/2006/114-382. January 2007 to september 2011: CAFNET: Connecting, enhancing and sustaining environmental services and market values of coffee agroforestry in Central America, East Africa and India.

[47] A.C. W. Craparo et.al. (2015). Coffea arabica yields decline in Tanzania due to climate change: Global implications. *Agricultural and Forest Meteorology* 207:1-10.

[48] M.B.P.D. Camargo. (2010). The impact of climatic variability and climate change on arabica coffee crop in Brazil. *Bragantia* 69(1):239-247.

[49] A.P.Davis. et.al. (2012). The impact of climate change on indigenous arabica coffee (Coffea arabica): predicting future trends and identifying priorities. *PLoS One* 7(11):e47981.

[50] Gay, C. et. al. (2006). Potential impacts of climate change on agriculture: A case of study of coffee production in Veracruz, Mexico. *Climatic Change* 79(3):259-288.

[51] M. Hartmann & Akasha B.M. (2009). *Emerging Challenges for Farm Labour in the Indian Coffee Sector*. Humboldt-Universitätzu Berlin. Department of Agricultural Economics. Division of Development Planning and Project Management.

[52] Jeff Neilson & Bill Pritchard. (2009). Value Chain Struggles: Institutions and Governance in the Plantation Districts of South India. Vol.93. John Wiley & Sons.

[53] C. Upendranadh (2010). Coffee Conundrum: Whither the Future of Small Growers in India?. *National Research on Plantation Programme and Development paper* (3).

[54] J.V.Higdon & B. Frei. (2006). Coffee and health: a review of recent human research. *Critical reviews in food science and nutrition* 46(2):101-123.

. It occurred to me, therefore, that coffee growers' experience of rainfall variation within their estates could be assembled as a fairly consistent narrative about weather patterns and inevitably as an informed and considered anxiety about climate change.

Fieldwork methodology: site selection and sampling

The field work for this study was essentially ethnographic in orientation. In the Western Ghats belt while selecting specific sites to study the impact of unprecedented weather variation it was important to be mindful of the variation that was characteristic of the topography. To address this problem bio-climate maps were used for choosing study sites. Bio-climates correspond to the biological climates, an idea introduced by Bagnouls and Gaussen (1957). They take into account the main climatic parameters such as rainfall and temperature but give emphasis to their regime (monthly values) and inter-annual variability, and to the length, intensity and season of occurrence of the dry period.[55]

Bio-climate maps of the Western Ghats made by J.P. Pascal in 1982 are accessible in the *Institut Fran¸cais de Pondich´ery* (Pondicherry University) website.[56] The bio-climate maps show the rainfall regime and the temperature regime. Rainfall regime refers to rainfall distribution during the course of the year. Temperature regime is established according to the annual variation in the mean monthly temperature. Here the maps are presented in two sheets (page 14 & 15).

In the main map, the flat colors correspond to the rainfall classes (dark violet, light violet, golden brown, yellow, orange red). Overprints (horizontal or vertical lines or

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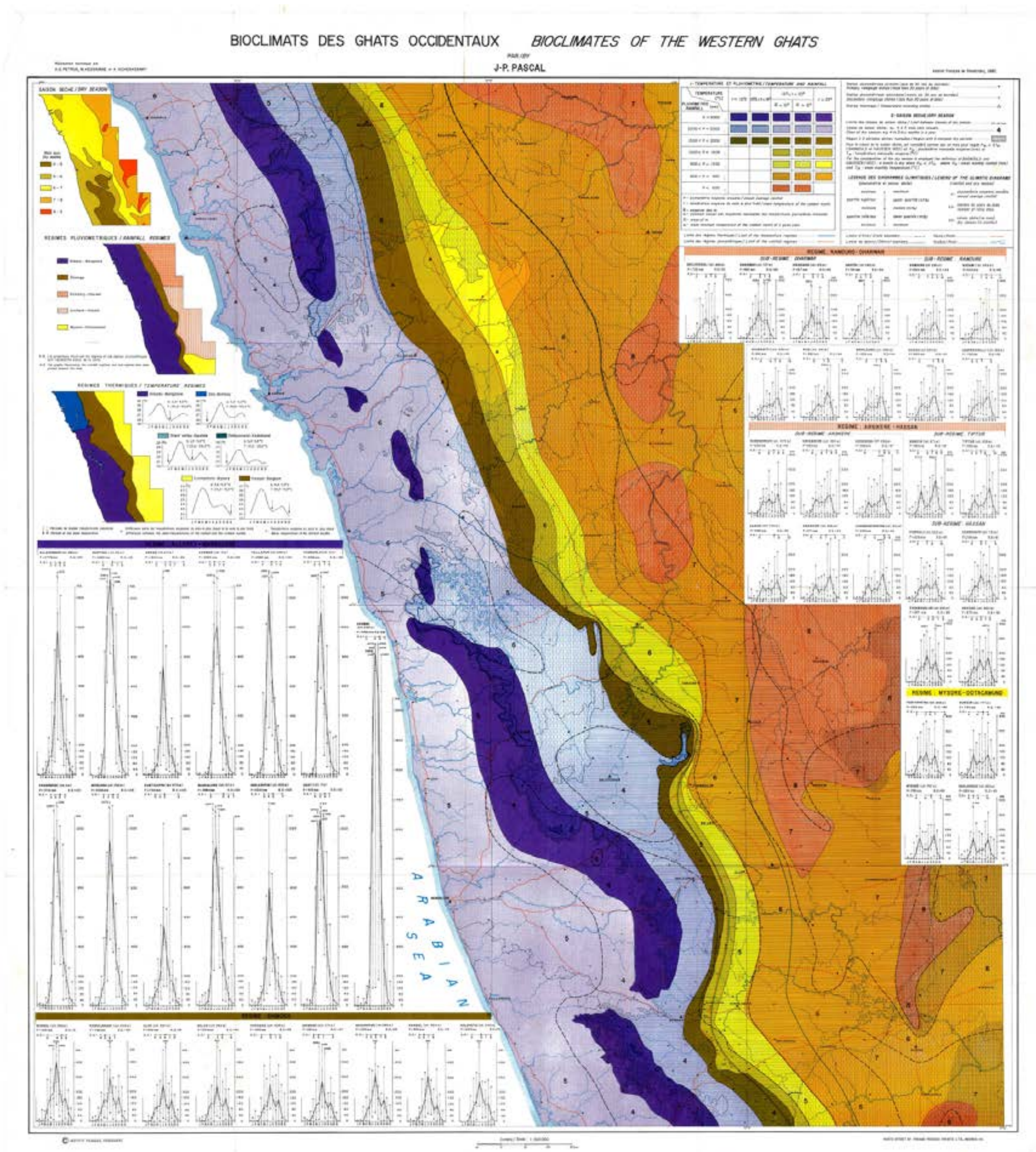
[55] Pascal, J. P. (1982). Explanatory notes on the bio-climate maps of the Western Ghats. https://hal.archives-ouvertes.fr/hal-00504742/document (6/6/2017).

[56] I was made aware of these maps during my interactions with the faculty of Ashoka Trust for Research on Ecology and Environment (ATREE). I am thankful to Dr. Nitin Rai, Dr. Bhaskar Acharaya and Venkat R. Ramani at ATREE for facilitating my talk and providing useful links to research works on rainfalls in Western Ghats. I was given an opportunity to present my work at ATREE, Bengaluru on September 6, 2012.

I am grateful to Dr. Krishna Acutaro at IIT Delhi for helping me read and understand the bio-climate maps.

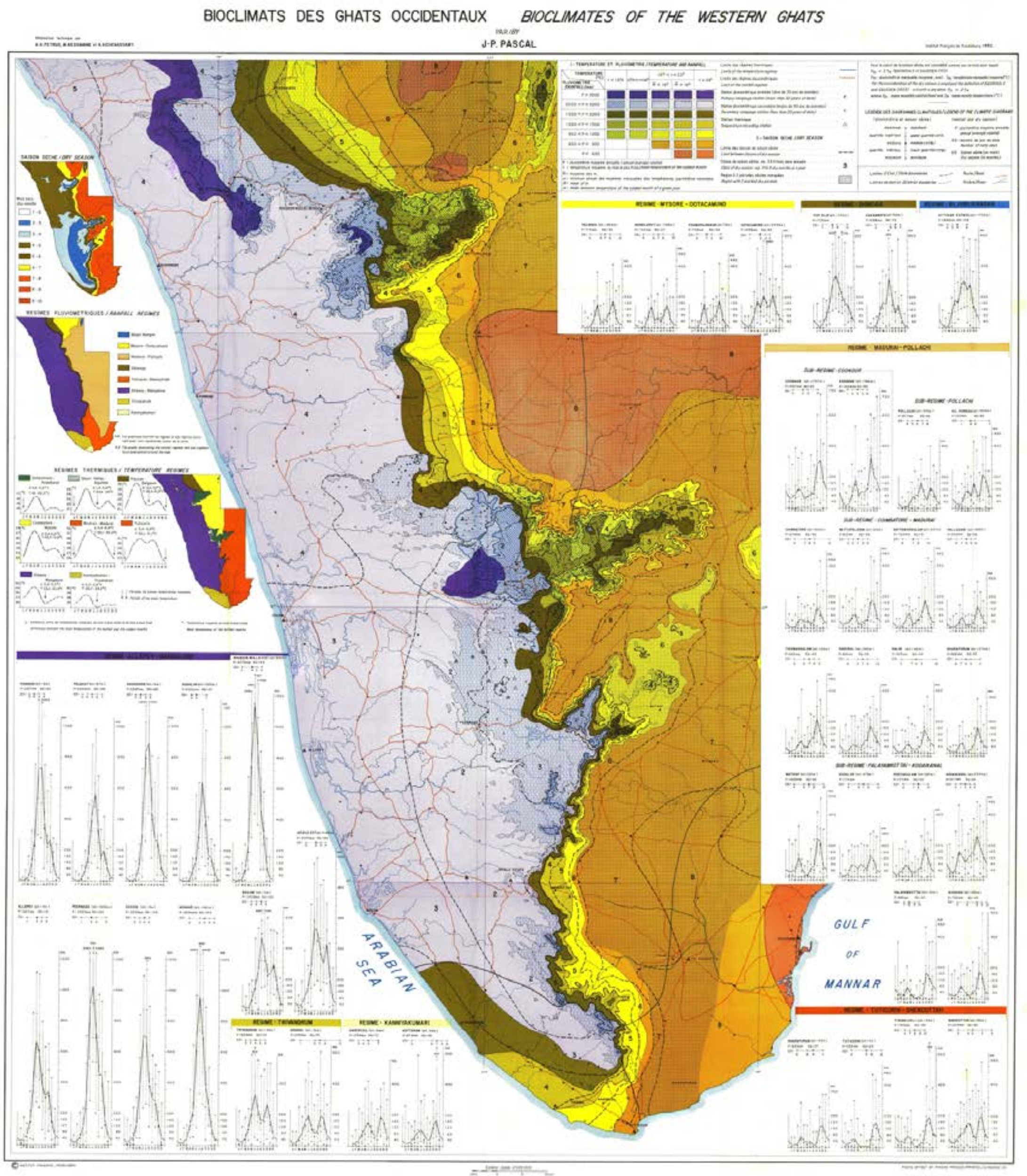
crosses) over these flat colors indicate temperature classes. Alongside the main map are provided graphical representation of monthly distribution of rainfall under the various rainfall regimes.

Map 2- Bio-climate map of Western Ghats - part1



Source: J.P.Pascal (1982), http://hal.archivesouvertes.fr/docs/00/50/47/42/ANNEX/Bioclimates_of_Western_Ghats_North_HS17.jpg (30-03-14).

Map 3- Bio-climate map of Western Ghats – part 2



Source: J.P.Pascal. (1982). http://hal.archives-ouvertes.fr/docs/00/50/47/42/ANNEX/Bioclimates_of_Western_Ghats_South_HS17.jpg (30-03-14).

For the purpose of this study we focus on coffee estates located in three specific rainfall regimes which correspond to three different rainfall producing mechanisms.[57] These are

A) Allepey-Mangalore regime: This regime is shown in blue color in bio-climate map-1. Under this regime rainfall is received through South-West Monsoon. Maximum rainfall is received in the month of July. During field work areas covered under this regime were: *Balehonnur* (*Chickmaglur* district, Karnataka), *Medikeri* and *Sunticoppa* (*Kodagu* district, Karnataka) and *Sakleshpur* (*Hassan* District, Karnataka).
B) Maduri-Pollachi regime (Subregime: Dudigal and Palini): This regime is regime is shown with mustard yellow color in bio-climate map-2. Under this regime rainfall is received through North-East monsoon. Earlier this was known as receding South-West Monsoon. Areas covered under this regime were: *Palini hills* (*Dundigal* district, Tamil Nadu). The maximum rainfall under this regime is received in the month of October.
C) Arsikere-Hassan regime: This is the transitional regime. It is shown in orange color in bio-climate map- 1. This regime receives rainfall from both South-West Monsoon and North-East Monsoon. Therefore maximum rainfall is received twice, once in July and then later in October. The selected area in this regime Chikmaglur and Hassan.

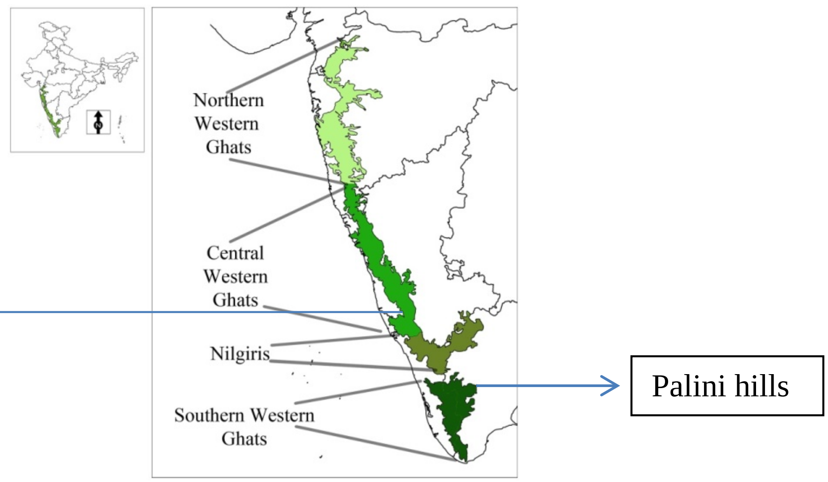
The sites thus selected to carry out field work for this study come under a specific part of the Western Ghats range, also known as the *Malnad*. The Malnad covers portions of six districts in the South Indian state of Karnataka, which accounts for 71% of the total coffee production in India.[58] Coffee estates are located in three of these six districts: Kodagu, Chikmaglur and Hassan. Along with these three districts I look at one more district that is located in the eastward extension of the Western Ghats in Tamil Nadu.

[57] Rainfall regimes refer to distribution of rainfall during the course of the year.

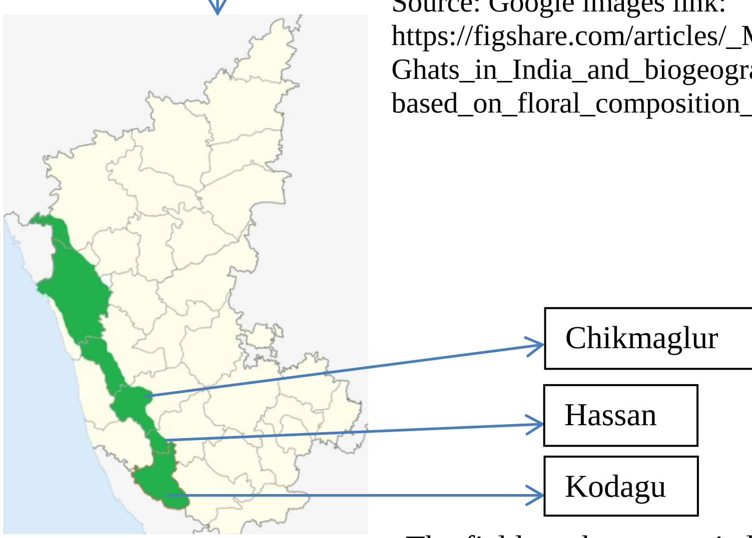
[58] For coffee data see annexure 14.
Also see, Coffee Board statistics. http://www.indiacoffee.org/coffee-statistics.html (15/8/2016).

This is the Palini hills region in the Dindigul district. Unlike the Malnad belt this region receives its rains from the North- East monsoon.

Map 4 : Western Ghats in South India



Source: Google images link: https://figshare.com/articles/_Map_showing_location_of_Western_Ghats_in_India_and_biogeographic_zones_within_Western_Ghats_based_on_floral_composition_46_/936435



Map 5: Western Ghats belt running through Karnataka state. This is also known as Malnad region.

Source: Google images link : https://en.wikipedia.org/wiki/Malenadu (22/1/2017)

The field work was carried out over a period of seven months that was spread out from November 2011 to March 2015. I visited 2 states, 4 districts, 8 taluks and 41 villages. Detail interviews were carried out with 82 coffee growers,[59] 61

[59] For details about interviews conducted see annexure 2,3,4.

other responded to a written set of questionnaire[60] and 19 more were interacted with during group discussions and association gatherings.[61] I conducted 26 interviews with scientists working on climate and weather science. Additionally, 54 other interviews were carried out. These interviewees included Coffee Board Officials, coffee scientists, Coffee Board extension officers, insurance officials, coffee traders & roasters, faculty at Indian Institute of Plantation Management, coffee tasters, journalists reporting about coffee, and others.[62]

Given the nature of my enquiries this thesis is largely ethnographic in orientation, with the methodological and qualitative approach being broadly influenced by the perspective of 'interpretivism' in the social sciences. In the interpretive tradition it is accepted that human societies cannot be studied in the same way as natural sciences. Qualitative interviews are an opportunity to delve and explore precisely those subjective meanings that positivists seek to strip away in their search of standardization.[63] The ethnographic study was carried through focused interviews after a small period was spent as participant observer to get myself sensitized with the social and ecological settings. In carrying out the analysis of the observations thus made I use the scenario methodology as a tool. The scenario methodology helps to challenge existing assumptions, identify novel lines of inquiry, and enable new research questions to emerge.[64]

Local observations and perceptions of change were elicited through a layered methodology that was couched within an ongoing participant observation style for systematically documenting phenomena. The use of this somewhat eclectic set of

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[60] For details about respondents of survey questionnaire see annexure 5.

[61] For details about these interviews see annexure 2,3,4.

[62] Detailed description of methodology used and areas covered during fieldwork is provided in chapter 3.

[63] Karen O' Reilly.(2005). *Ethnographic Methods.* New York: Routledge.p.114 .

[64] R. Ramirez. et.al.(2015). Scenarios as a scholarly methodology to produce 'interesting research'. *Futures* 71: 70-87.

methodologies was intended to fine-tune my efforts at documenting a range of every day experiences and observations on the ground. This was done through semi-structured interviews, structured interviews, participant observations, surveys and focus groups discussions.

Navigating the thesis

This thesis is aimed at trying to understand, document and explore anxieties and experiences about climate change at the local or in situated contexts. Chapter 2 titled 'Science and Situated Knowledge' discusses and critiques the framing of climate change from what Donna Haraway calls the 'God's eye view'. As a 'privileged narrative', the God's eye view sees planet earth by decontextualizing the viewer. I argue in this chapter that such a de-contextualized view of the earth often renders the everyday experience of weather and the broader patterns of climate un-relatable at the local level. This chapter argues the use of Haraway's concept of situated knowledge for studying climate change on the ground. Further ahead this chapter makes a case for the need to rethinking adaptation from STS perspective.

In chapter 3 titled 'On a Coffee Trail', I reflect on the ethnographic methods that enabled me to carry out my field work observations and documentation. Ethnography, I argue, is about assembling credible and compelling stories from field work through a range of strategies involving interviews and observations. I intend, in particular, to understand the everyday world of coffee growing and decision-making in order to map and explain how everyday weather is talked about and experienced at the local and situated level.

In Chapter 4 titled 'Everyday Politics of Climate Change', I discuss the perplexing debate over the differing narratives over what constitutes 'normal' rainfall for coffee growers, meteorologists and insurers. This chapter goes on to also further discuss the contentious issue of what comprises 'unprecedented variation' in the rainfall pattern. I will aim to point out here that the understanding of rainfall variation is grasped differently by coffee growers, the meteorologists and the insurers. Having then identified these conceptual and definitional differences, I go on to nonetheless also identify overlaps and the implications from what emerges to also be several shared perspectives over rainfall variation.

In Chapter 5 titled 'Insurance and Irrigation', I identify two main strategies that are available to growers for addressing their concerns with regard to rainfall variation. These strategies are a) irrigation (sprinkler and rain-gun) and b) Rainfall Insurance Scheme for Coffee (RISC). While irrigation requires credible weather forecast to inform decision making, the RISC, on the other hand, demands that observed rainfall data be gathered at regular and in a statistically consistent manner by a network of standardized rain-gauges. This chapter goes on to explore the vulnerabilities that arise as growers try to inform their decision making process after investing in the above mentioned strategies (irrigation and RISC). The chapter argues that upon investing in these strategies source of vulnerability for growers shifts from weather event to meteorological information about the weather event.

Chapter 6 titled 'Calculating Rainfall' unpacks the several meanings of what comprises a meteorologically successful rainfall forecast. The chapter points out the difference between what constitutes a useful forecast and a meteorologically successful forecast. The chapter argues that growers pick and choose the source of information depending on their specific requirement. For the growers success of forecast depends on the autonomy of interpretation. Meteorologists on the other hand understand a forecast through formal, institutional and structured system of perceiving rainfall as precipitation in terms of absolute numbers. For them the success of a forecast depends on the performance of certain statistical tools.

Chapter 7 'Bulls, Bears and Rainfall' explores the complicated relationships between coffee prices and growers. This chapter identifies four different price and rainfall scenarios which a grower might find himself/herself in. This relation is particularly important, I argue, for understanding investment decision in strategies which depend on meteorological information. By bringing in the market calculation the chapter argues that from a growers' perspective the decision to invest in these strategies is not a choice between less vulnerable or more vulnerable scenarios. Rather it becomes a choice between two different kinds of vulnerabilities with regard to decision-making for growing coffee. This chapter argues that for a coffee grower, the impacts of variation in rainfall go much beyond the simple average or total rain that falls. These arguments, in particular, try to explain why simply improving meteorological information through scientific rigor does not or need not always carry appeal with growers in all contexts.

Chapter 2

Science and Situated Knowledge: A conceptual framework

> *Less than 550 humans have orbited the earth. Those of us lucky enough to have done so for more than once have not only heard about negative impacts of climate change on our planet we have seen it with our own eyes.*

Astronaut Michael Lopez

> *From our vantage point from 250 miles above the earth's surface we can see how precious the earth is.*

Astronaut Scott Kelly

These are excerpts from the video 'Call to Earth: A message from world's astronauts'.[1] This eight minute long video marked the opening of the Paris climate conference, better known as COP 21, on 31st November, 2015. Why were astronauts, especially the ones who were not on planet earth at that moment, considered the best spokespersons for addressing the august gathering made up of diplomats, government officials and heads of state? Why is climate change so clearly visible to those who are not on the planet, while it gets endlessly debated by those who are living in the middle of it? To put it differently, why do we have to leave the planet to be convinced of the realities of climate change?

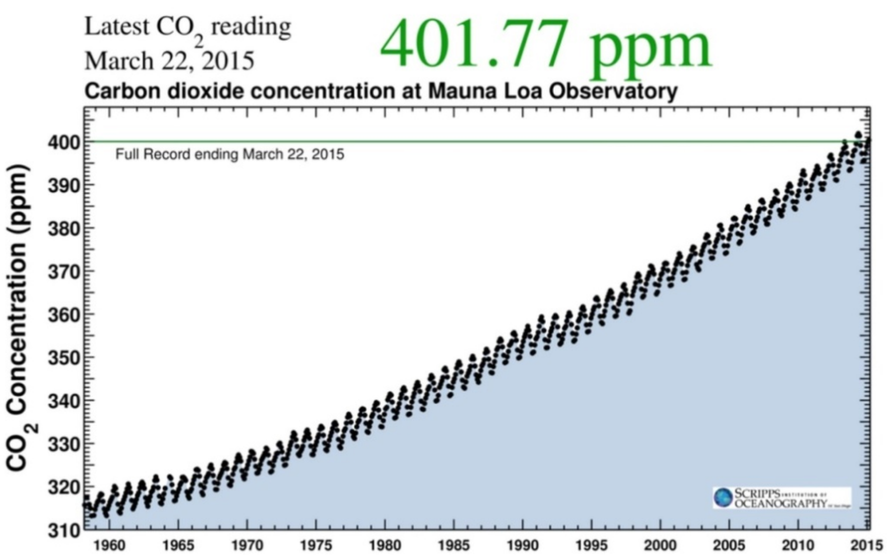
This is where our story begins.

[1] *Call to earth : A message from world's astronauts*, link : https://www.youtube.com/watch?v=NN1eSMXI_6Y (18/7/2016)

How did we reach here?

How have we arrived at this point in climate change discussions that we need to grasp planet earth from space rather than feel the heat on the ground, so to speak? To understand how we have reached where we are it is useful to look back at the paths which have been used for arriving at our current state of knowledge. Most if not all the works tracing the history of climate change start from the Keeling curve. The Keeling curve represents the measured concentration of carbon-di-oxide in the atmosphere that has been regularly recorded at the Mauna Lao Observatory (Hawaii) since 1958, when Charles David Keeling began measuring carbon-di-oxide with his manometers there.

Graph 1: Keeling curve showing carbon-di-oxide (CO_2) concentration at Mauna Loa Observatory on March 22, 2015.



Source: Scripps Institution of Oceanography, https://scripps.ucsd.edu/programs/keelingcurve/ (18/7/2016).

In 1958, Keeling found that for every million units or parts of the mélange of gases we call the atmosphere, 315 parts comprised carbon-di-oxide molecules (CO_2). In

2013, that number of parts per million CO_2 crossed 400.[2] But what lead Keeling to record the concentration of CO_2? In 1957, just before Keeling's project took off, his oceanographer boss Roger Revelle along with a radio-chemist named Hans Suess demonstrated geochemically that humans were, as few scientists before them had claimed, contributing CO_2 from fossil fuels to the global atmosphere. The events that drew their attention to CO_2 , in fact, go even further back in time. Between 1859 and 1862, the Irish physicist John Tyndall confirmed experimentally that CO_2 absorbed radiation and therefore acted to regulate the temperature of the atmosphere and the earth. In 1869, Noble laureate Savnte Arrhenius estimated that the doubling of the then CO_2 in the atmosphere would cause about a 5^oC rise in the earth's mean temperature.[3]

One of the most significant contributions towards planetary understanding of the atmosphere was made by T. C. Chamberlin.[4] He argued that atmosphere is a fundamental geological agent.[5,6] This was an important shift because establishing atmosphere as a fundamental force implied that the climate ought to be maintained in a certain way. The challenge, thus, for early twentieth century scientists was to understand the ideal global atmospheric conditions that was suitable to human survival and needs. James Rodger Fleming in his highly acclaimed work *Historical Perspectives on Climate Change* refers

[2] Joshua P. Howe. (2014). *Behind the curve: Science and the Politics of Global Warming*. Seattle: University of Washington press. pp.3-5.
[3] Ibid.,p.7.

[4] T.C.Chamberlin (September 25, 1843- November 15, 1928) was a American geologist and educator. He was also the founder of *Journal of Geology*.

[5] T.C Chamberlin .(1897).The Method of Multiple Working Hypothesis. *Journal of Geology* 5:837-48.

[6] T.C. Chamberlin and Rollin D. Salisbury.(1907). Geology Vol.3, Earth History, 2nd ed. Rev. New York: H.Holt.

to this perspective from which emerges our current understanding of global climate change as the 'privileged knowledge' approach.[7]

The first scientist credited for observing climate change on the ground, however, was Alexander von Humboldt (1769-1859).[8] His observations were made much before the geological role of atmosphere was scientifically discovered.

> After he saw the devastating environmental effects of colonial plantations at lake Valencia in Venezuela in 1800, Humboldt became the first scientist to talk about harmful human – induced climate change.
>
> He warned that humans were meddling with the climate and that this could have an unforeseeable impact on the future generations.

-*Invention of Nature* by Andrea Wulf [9]

Humboldt's observations, in fact, argued a certain global understanding of the world which was different from the planetary imaginations that emerged following Chamberlin's work. In Humboldt's understanding everything was 'closely connected' and 'everything was interaction and reaction'.[10] He gave the concept of nature as a 'natural whole'. How is Humboldt's climate of the 'natural whole' different from the planetary global climate that we have come to understand?

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[7] James Rodger Fleming. (1998). *Historical Perspectives on Climate Change*. New York: Oxford University Press. p.83.

[8] Alexander von Humboldt (1769-1859) was a geographer, naturalist and explorer. His work informs our current understanding of ecology, bio-geography, climate and weather science.

[9] Andrea Wulf in her work *The Invention of Nature* cites an excerpt from Alexander Von Humboldt's *Personnel Narrative* (1814-29) to argue that Humboldt was the first scientist to talk about harmful human – induced climate change.

Andrea Wulf .(2015). *The Invention of Nature: The adventures of Alexander Von Humboldt ,The Lost Hero of Science*, John Murray Publications. p.5 &57.

[10] Ibid., p.87

Global planet and the natural whole

The first image of planet earth free floating in space also known as *The Blue Marble* image was taken on December 7, 1972 by the crew of the Apollo 17 space craft on their way to Moon. The image was clicked at a distance of around 45000 kilometers from earth.

Picture 2:Blue Marble image of Earth.

Source: White House Website. link: https://www.whitehouse.gov/blog/2015/07/20/new-blue-marble

Picture 3 :Earth rise from moon.

Source: NASA website. link:http://www.nasa.gov/multimedia/imagegallery/image_feature_1249.html (last visited 23/6/2016)

Prior to this in December 1968, the crew of Apollo 8 who were the first humans to leave the orbit of the earth for Moon sent the first images of what were famously titled as 'earth rise'. On Aug. 23, 1966, the world, in fact, received its first view of planet earth taken by a spacecraft from the vicinity of the Moon. The photo was transmitted to Earth by the Lunar Orbiter I and received at the NASA tracking station at Robledo De Chavela near Madrid, Spain.

Even though the first planetary images of earth were received only by 1966, planetary understanding of earth had emerged much before these pictures had arrived. Interestingly, the global environmental concerns which are most commonly associated with the *Blue Marble* image of planet earth did not emerge organically out of it. Shiela Jasanoff in her influential essay *Image and Imagination* argues that the reception of earth's image in space (from here on referred to as 'the image') did not have straight forward connections with environmental thought.[11] She argues that even though the image was picked to reinforce the themes of earth's fragility and finiteness in the overall analysis it conveyed a serene disregard for local human conditions.

Using the image of earth to invoke global environmental concern overlooks a basic instinct. It assumes that seeing and experiencing are the same thing. As we look at the image of earth what is it that we experience? We experience a sense of immensity, awe and a sense of achievement. What about the astronauts, who were specifically chosen to share their views at COP 21? What did they actually experience about the earth? In space would astronauts' experience of the many sunrise and sunsets within a 24 hour cycle suffice for experiencing the earth, along with its many and complicated environmental travails, at a global scale? Astronauts who have been to outer space have compared earth in space to a 'little Christmas- tree ornament against an infinite black backdrop of space'[12] or to 'one grain of sand on a beach'.[13] The analogies they used for

[11]Shiela Jasanoff.(2001). Image and imagination: the formation of global environmental consciousness. *Changing the atmosphere: Expert knowledge and environmental governance* in *Changing the atmosphere: Expert Knowledge and Environmental Governance*, (eds.) Clark Miller and Paul N. Edwards. pp 309-337.

[12] Tim Folgers, Sarah Richardson and Carl Zimmerman. (1994). Remembering Apollo: Astronauts recall their flights to the moon. *Discover* 15(7):38.

Cited in Sheila Jasanoff. (2012). *Science and Public Reason*. Oxon, New York: Routledge. p.88.

sharing their experience can hardly be framed as being global. How do, then, we comprehend that which is played out on a vastly different spatial and temporal dimension?

This brings us back to Humboldt's idea of the 'natural whole'. The understanding that local actions have far-reaching environmental impacts grew alongside the planetary understanding of earth. Rachel Carson's *Silent Spring* (1962), James Lovelock's *Gaia Theory* (1974) and George Perkins Marsh's work *Man and Nature* (1864) in which he argued 'We can never know how wide a circle of disturbance we produce in the harmonies of nature when we throw the smallest pebble in the ocean of organic life'[14] developed from the idea of the natural whole. The idea of natural whole which emerged from the situated experience of having lived at a specific locale and from which these classical environmental works emerged came to be, in fact, seen as the opposite of the global earth that was made visible only with the help of space technologies. The following table below delineates these differences:

Table 2: Difference between 'Natural Whole' and the 'global' earth

	Natural Whole	**Global**
1.	The whole emerges from the interconnections of the parts.	The 'global' is given to us all at once by the technology that is looking at it. Satellite images and global models.
2.	The essence of this concept is that everything is connected to everything else. This concept focuses on relationships.	The relationships are forged with the given 'global' in order to draw meaning from what is visible to the eyes.

[13] Ibid.

[14] George Parkins Marsh.(1898).*The Earth as modified by Human action: The last revision of 'man and Nature'*. New York: Charles Scribner's sons: 354-349. p.33.

3.	The whole is not fixed it is open to imaginations emerging from the different interconnections. The concept argues for 'a great chain of causes and effects' and that 'no single fact can be considered in isolation'.	It is used for representing 'fragility and finiteness' along with planet's irreplaceability 'it being our only planet.' By explicitly defining what you are looking at image represents a closed system
4.	Here vulnerability is understood as a function of interconnections and interdependence. Any link that the chain loses will affect every other being.	Vulnerability is understood as the limited set of resources that our planet has to offer. It being irreplaceable as of now.
5.	Here the whole emerges from the connections forged between the parts. Hence there is no gap between the immediate and distant; parts and the whole.	The global exists independent of the local. We can see the whole earth without being at any defined place on it (view from nowhere). The divide between local and global exists which is repeatedly bridged through relations forged afterwards such as: 'think globally, act locally' or 'Glocal'.

Source: Primary work.

While the concept of 'natural whole' experiences the earth without necessarily seeing it in any fixed form, the 'global' draws meaning from the planetary images provided by satellites and climate models. Because local is not needed to imagine the 'global', the 'global' is thus rendered irrelevant in everyday life which is then lived with in fixed and defined localities. As the planetary global understanding of earth gains strength independently of any contributions from the local experience of living on the planet, the local is being increasingly posed as the 'other' or as the alternative to the global.

Global vs Local: it is not a scale issue

Scale is defined as comprising spatial, temporal, quantitative or analytical dimensions that help us to measure and study any phenomenon. In climate change debates, the scale issue is often discussed in terms of the global vs local divide. One of the immediate consequences of viewing the climate change discourse in such a 'global' and 'local' binary is to also acknowledge scale discordance. Scale discordance is defined in terms of a mismatch occurring when available scientific information does not reflect the unique context of the environmental conditions and/or the geographic scale for decision making.[15]

The 'global scale' of climate represents nature as the physical reality which is a given and exists independent of human beings. The 'local scale', on the other hand, is the one in which we live and which we create through our actions and which in turn affects us. It is people, their engagements and interactions. Tim Ingold argues that the distinction between the global and local perspective is not one of hierarchical degree ─ in scale or comprehensiveness ─ but one of kind. Local is not a more limited or narrowly focused apprehension than the global; it is one that rests on an altogether different mode of apprehension, based on practical perceptual engagement with components of a world that is inhabited or dwelt-in, rather than on the detached disinterested observation of a world that is merely occupied.[16]

To further argue how these two are different kinds of knowledge systems, Ingold in his book *Being Alive* cites a study by psychologists Stella Vosniadou and William F. Brewer in which they experimented with school children aged between six to eleven

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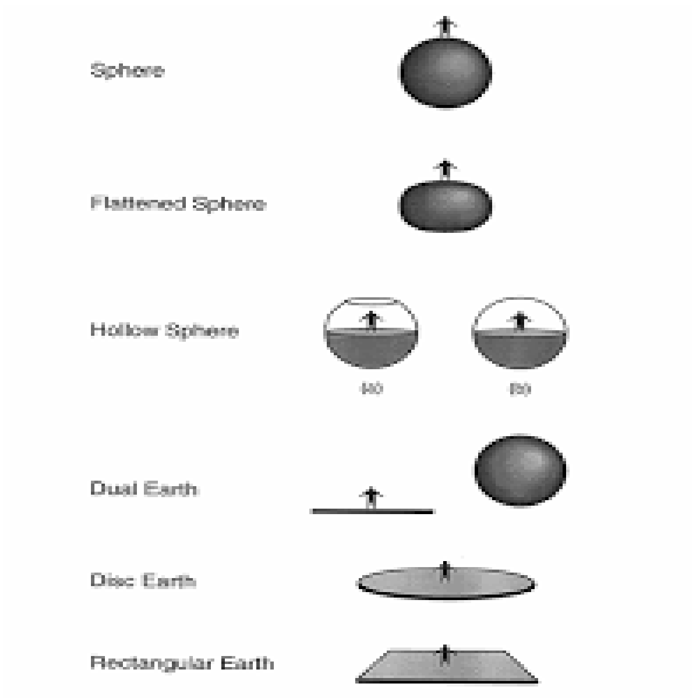
[15] E. Gordon et.al. (2015). Navigating scales of knowledge and decision-making in the Intermountain West: implications for science policy. *Climate in Context: Science and Society Partnering for Adaptation*. Chichester, UK : John Wiley & Sons, Ltd: 235-254. p. 239.

[16] Tim Ingold. (2011). *Being alive: Essays on movement, knowledge and description.* Oxon: Routledge p.100

years to identify developmental sequence in thinking about the earth. The children everywhere, regardless of cultural background, presuppose that a) ground is flat b) unless supported things fall. To grasp a counter-intuitive understanding that the earth is round like a ball and that people can live everywhere without falling off calls for a complete conceptual restructuring of the child's mind. Vosniadou and Brewer highlights this through various models that children used for synthesizing their initial presupposition with the information supplied by their teachers or gleaned from books charts or other sources.[17]

Picture 4: Mental models of earth.



Source: Originally published in Vosniadou, S., & Brewer, W. F. (1992). Mental models of the earth: A study of conceptual change in childhood. *Cognitive psychology* 24(4): 535-585.
Reprinted in Tim Ingold. (2011). *Being Alive: Essays on movement, knowledge and description*. Taylor & Francis., p.100

[17] Ibid, pp.101-109.

Ingold uses this study to argue that the hybrid characters of these diagrams and the contradictions to which they give rise, is not a symptom of children's transitional status between the naïve intuition that the earth is flat and the informed knowledge that it is really a sphere. It is rather indicative of a more fundamental existential dilemma, as pressing for adults as it is for children, and indeed for philosophers as it is for laypersons, that arises when access to what passes for certain kind of knowledge ─ in this case of the shape of the earth ─ is predicated upon the renunciation of the very experience of inhabiting the earth that makes this knowledge possible.[18]

In the climate change context it is reflected in attempts to comprehend climate at a spatial and temporal scale that goes beyond common people's everyday experience, and people may perhaps have to renounce the everyday experience of weather that makes the concern for climate relevant in the first place. For instance, concern about rise in global temperatures by 2^{o}C is difficult to comprehend on an everyday basis where people experience greater variation within a diurnal cycle.

Climate science and local knowledge: the limitations

In much of the existing technical literature on climate change, the global scale is often conceived off through scientific instrumentations like GCM models. It includes bio-geophysical systems. It provides overarching views of possible future climatic scenarios over a period of 10, 50 or even 100 years. The local scale, on the other hand, is conceived on the basis of everyday weather experiences. In order to address the scale issue, thus identified, more recently there have been calls to go beyond the scientific representation of climate change and explore local knowledges.[19] Since beginning, climate science is at the heart of climate change debates and discussions. It forms the basic framework of the debate in which climate science's ability to represent climatic conditions at a global scale

[18] Ibid., p.113

[19] Heike Greschke & Julia Tischler.(2015). *Grounding Global Climate Change: Contributions from the social and cultural sciences* New York: Springer.

gave scientists a privileged voice in institutions such as the Intergovernmental Panel on Climate Change (IPCC) and the United Nations Framework Convention on Climate Change (UNFCCC).

The issue of local knowledge in relation to climate change was covered by the IPCC's Working Group II in the Fourth Assessment Report (2007). The term 'local knowledge' was, in fact, used simultaneously with 'indigenous knowledge' and 'traditional knowledge' so as to indicate their interchangeability. Moving on to 2014, these terms were once again used in the Fifth Assessment Report of IPCC's Working Group II. Much like the Fourth Assessment Report they were again grouped together and like in the previous report were used interchangeably. However, unlike the Fourth Assessment Report, the Fifth Assessment Report provided a guiding definition for traditional knowledge and therefore by extension these definitions were applicable to indigenous and local knowledge as well.

> Traditional knowledge includes the knowledge, innovations, and practices of both indigenous and local communities around the world that are deeply grounded in history and experience. Traditional knowledge is dynamic and adapts to cultural and environmental change, and also incorporates other forms of knowledge and viewpoints. Traditional knowledge is generally transmitted orally from generation to generation. It is often used as a synonym for indigenous knowledge, local knowledge, or traditional ecological knowledge.[20]

Traditional knowledge is thus a body of knowledge that is drawn from historical contexts and can be passed on to the next generation and can incorporate changes as well. This knowledge is thus expected to contribute to climate science by offering observations and interpretations at a much finer spatial scale with considerable temporal depth, and thereby being able to highlight elements that may not be considered by climate

[20] John Agard, E Lisa F. Schipper (2014). Glossary, IPCC. Climate change p. 1774. https://www.ipcc.ch/pdf/assessment-report/ar5/wg2/WGIIAR5-AnnexII_FINAL.pdf (5/6/2017).

scientists.[21] Traditional knowledge, accordingly in such an understanding is equivalent to indigenous knowledge that is possessed by indigenous people who are:

> Those that, are having a historical continuity with pre-invasion and pre-colonial societies that developed on their territories, consider themselves distinct from other sectors of the societies now prevailing on those territories, or parts of them. They form at present principally non-dominant sectors of society and are often determined to preserve, develop, and transmit to future generations their ancestral territories, and their ethnic identity, as the basis of their continued existence as peoples, in accordance with their own cultural patterns, social institutions, and common law system.[22]

The environmental management literature discusses many more forms of knowledges such as personal, lay, tacit or implicit knowledge while highlighting the challenges and opportunities in thinking through environmental conservation from knowledge perspective.[23, 24, 25, 26, 27, 28] For the purpose of this study, however, I flag the

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[21] Douglas J. Nakashima., Kirsty Galloway McLean., et. al.(2012). *Weathering Uncertainty: Traditional Knowledge for Climate Change Assessment and Adaptation*. Paris, UNESCO, and Darwin, UNU, 120 p.7.

[22] John Agard, E Lisa F. Schipper (2014). Glossary, IPCC. Climate change P. 1767. https://www.ipcc.ch/pdf/assessment-report/ar5/wg2/WGIIAR5-AnnexII_FINAL.pdf (29/7/2016).

[23] Christopher M. Raymond., Ioan Fazey., et.al. (2010). Integrating local and scientific knowledge for environmental management. *Journal of Environmental Management*. 91(8):1766-1777.

[24] Michael Polanyi.(1997). Tacit knowledge in *Knowledge in Organisations*. (ed.) Prusak, L. Boston, USA: Butterworth-Heinemann.

[25] Ioan Fazey., J.A. Fazey., D.M.A. Fazey .(2005). Learning more effectively from experience. *Ecology and Society* 10 (2): 4.

[26] Michael Polanyi. (1958). *Personal Knowledge: Towards a Post-critical Philosophy*., London, UK: Routledge.

limitation of local, traditional and indigenous knowledge because these are the terms the IPCC reports deal with when they argue for going beyond the scientific knowledge framework.

Traditional, indigenous or local knowledge as argued in the IPCC reports represents observations and interpretations of meteorological phenomenon which have guided seasonal or inter-annual activities of local communities for millennia.[29] This is reflected in the studies carried out to gather traditional knowledge on the ground. For instance, the following table from a study by R. Rangalaxmi share examples of traditional knowledge which appear to resonate with the ideas and definitions as proposed in the IPCC assessment reports.[30]

Table 3. Indicators, reliability and related decisions.

S.no	Indicators	Reliability and Related Decisions	Indicators Decisions Reliability
1.	Medium and high Weather indicators: 24hrs indicators. If lightening occurs from east, west and	Indirectly helps to mobilize labor for	High, still date it

[27] Ioan Fazey, I. et.al (2006). Eliciting the implicit knowledge and perceptions of on-ground conservation managers of the Macquarie marshes. *Ecology and Society* 11 (1): 25-52.

[28] Ioan Fazey et. al. (2006). The nature and role of experiential knowledge for environmental conservation. *Environmental Conservation* 33(1):1-10.

[29] J. Douglas J.et. al.(2012). *Weathering Uncertainty: Traditional Knowledge for Climate Change Assessment and Adaptation*. Paris, UNESCO, and Darwin, UNU, 120 p.7.

[30] Rengalakshmi, R. (2008). Linking traditional and scientific knowledge systems on climate prediction and utilization. *MS Swaminathan Research Foundation, Chennai*.

	south expect rain immediately.	weeding, day to day activities like shifting the cattle's, other livestock and poultry birds to the shed, organizing the fuels under shade, very rarely used for pesticide application Drying and collecting the dried products from the drying yard	is commonly used, both men and women are using.
2.	If lightening comes in an opposite direction (East to west) expect rain in another one hour.	- do - Mostly used to take decisions related to the above activities.	Very high, common and used by large number of farmers, both are using.
3.	If it happens in south east and north west directions - expect rain in the night.	Used to take decision on picking up fruits/flowers which are supposed to done in the next day morning.	High, commonly used by all the farmers.
4.	Rings around sun	Used to decide irrigation, labor arrangement, fertilizer application and irrigation.	High commonly used by all farmers.
5.	Belief is if there is a more mosquito bite.	Supportive indicator	Rare

Source: Rengalakshmi, R. (2008). Linking traditional and scientific knowledge systems on climate prediction and utilization. *MS Swaminathan Research Foundation, Chennai*. http://www.millenniumassessment.org/documents/bridging/papers/raj.rengalakshmi.pdf (29/7/2016)

More recently there have been calls for community-based adaptation which requires going beyond the scientific representation of climate change and exploring local/ traditional/indigenous knowledges. However, this conceptualization of adaptation aims at using local knowledge to a) complement broader scale scientific research with local precision and nuance[31], b) use it as a source of environmental monitoring for the changing climatic conditions[32] c) exploring the landscape of local knowledges in order to contextualize scientific findings.[33]

The attempt of bringing together science and traditional/ local/ indigenous knowledge is problematic because any such attempt will first need to identify traditional/ local/ indigenous knowledges; which will derive from a secondary set of non-factual expertise whose defining characteristic will be being unexposed/untainted by the scientific knowledge in the field. The governing system then goes on to tap into this knowledge system to cheery pick the information snippets which best fix the requirements of science.[34,35,36,37,38] [39] The problematic inherent in this kind of integration

[31] D.J. Nakashima, K. Galloway Mclean, H.D. Thulstrup, A. Ramos Castillo and J.T. Rubis (2012), *Weathering Uncertainty: Traditional Knowledge for Climate Change Assessment and Adaptation*, Paris, UNESCO and Darwin, UNU: 24.

[32] Ibid; p.25.

[33] H. Nowotny, P.Scott, M.Gibbons (2001), *Rethinking Science; Knowledge Production in an Age of Uncertainty*. Polity Press, Cambridge.

[34] IPCC Climate Change (2014), Impacts, Adaptation, and Vulnerability. *Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. USA Cambridge University Press*, p. 204.

[35] Gugulethu Zuma-Netshiukhwi et. al. (2013). Use of traditional weather/climate knowledge by farmers in the South-western Free State of South Africa: Agrometeorological learning by scientists. *Atmosphere* 4(4):383-410

[36] D. Green & G. Raygorodetsky. (2010). Indigenous knowledge of a changing climate. *Climate Change* 100(2): 239–242.

[37] Gotzone Garay-Barayazarra and Rajindra K Puri.(2011) Smelling the monsoon: Senses and traditional weather forecasting knowledge among the Kenyah Badeng Farmers of Sarawak, Malaysia. *Indian Journal of Traditional Knowledge* 10 (1): 21–30.

[38] Ben Orlove et.al. (2010). Indigenous climate knowledge in southern Uganda: The multiple components of a dynamic regional system. *Climate Change* 100(2): 243–265.

is highlighted in the sociology literature. Reiner Grundmann and Nico Stehr suggests that the peculiar lack of sociological interest in the climate change debate was perhaps arguably being brought on by the dominance of the 'modeling community' who want social science to fill in the data gaps :

> The study of climate change largely, though not exclusively, amounted to the development and refinement of global circulation models that depend crucially (among other things) on sound input data. Climate modelers are keen to get usable data from other academic communities but only if these are in the 'right format' so to speak.[40]

This trend is further reflected in the works which argue that indigenous knowledge can meaningfully contribute by 'filling the gaps' in formal knowledge systems of climate and weather science.[41] One being the location specific and detailed micro level knowledge (indigenous, traditional or local knowledge), which are in contrast with the regional and global scale models that operate at the meso and macro levels.[42]

Situated knowledge and STS perspective

In order to engage with the global and local binaries with regard to climate change adaptation I draw insights from the Science Technology Studies (STS) perspectives. One of the key issues in STS work is people's engagement with science and particularly the

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[39] Miriam Kalanda-Joshua et.al. (2011). Integrating indigenous knowledge with conventional science: Enhancing localized climate and weather forecasts in Nesa, Malunje, Malawi. *Physics and Chemistry of the Earth* 36:996–1003.

[40] Reiner Grundmann and Nico Stehr .(2010). Climate change: what role for sociology?: A response to Constance Lever- Tracy. *Current Sociology* 58(6):901.

[41]. Winnie K. Luseno., et. al. (2003). Assessing the value of climate forecast information for pastoralists: Evidence from Southern Ethiopia and Northern Kenya. *World Development* 31(9): 1477-1494.

[42] Chinwe Ifejika Speranza et. al. (2010). Indigenous knowledge related to climate variability and change: insights from droughts in semi-arid areas of former Makueni District, Kenya. *Climatic Change* 100(2): 297.

ability to debate whether science frameworks offer the only legitimate forms of knowledge? Drawing on STS literature it can be argued that an epistemological line is conventionally drawn by scientific institutions between areas where public engagement is seen to be legitimate (on issues of ethics and values) and those where it is not (matters requiring specialist scientific knowledge and expertise).[43,44,45,46,47,48] This epistemological dividing line has been productively challenged by STS scholars.[49]

The point here is neither to romanticize alternative forms of knowledge[50] nor to replace science as being the only means for understanding the physical world. But to suggest that in climate change studies people's situated experience of weather represents more than a secondary 'nonfactual' data set. The notion that groups of citizens may bring relevant forms of knowledge and expertise to scientific processes has been widely reflected in STS studies.[51,52,53] Bloor, for example, in a study documented the opinions

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[43] Brian Wynne. (1995).Public Understanding of Science in *Handbook of Science and Technology Studies*, eds. Sheila Jasanoff, Gerald E. Markle, James C. Petersen, and Trevor Pinch. Thousand Oaks, CA: Sage.

[44]Petersen, & Trevor Pinch (eds) .(1995). *Handbook of Science and Technology Studies*, 361-388, London: Sage.

[45]Alan Irwin. (1995). *Citizen Science: A Study of People, Expertise and Sustainable Development.* London:Routledge.

[46] Stephen Zavestoski et.al.(2002). Science, Policy, Activism and War: Defining the Health of Gulf War Veterans. *Science, Technology & Human Values* 27(2): 171–205.

[47]Alan Irwin & Brian Wynne (eds). (1996). *Misunderstanding Science? The Public Reconstruction of Science and Technology.* Cambridge: Cambridge University Press.

[48] Andrew L. Roth, et. al. (2003). Framing Processes in Public Commentary on U.S. Federal Tobacco Control Regulation. *Social Studies of Science* 33(1): 7–44.

[49] S.O. Funtowicz, & J. Ravetz.(1993).Science for the Post-Normal Age. *Futures* 25(7): 739–55.

[50] Alan Irwin & Mike Michael (2003) *Science, Social Theory and Public Knowledge.* Maidenhead, U.K.: Open University Press.

between groups of coal miners on 'black lung' and contrasted that with the scientific understandings of pneumoconiosis. In such cases knowledge is not simply a matter of 'knowing' that there may be a connection between certain forms of exposure and patterns of mortality/morbidity on black lung disease but that it is also a matter of 'knowing' through experience the intricate connections about how the system works.[54] Furthermore, knowledge in such contexts becomes an active process of sense-making.[55,56]

The concept of situated knowledge best captures the complexity at hand. It argues that knowledge and understanding are contextually generated and simultaneously embody understandings of both the natural and social worlds. The term situated knowledge is most associated with feminist geographers and their critiques of the process of knowledge production. Drawing inspiration from the works of Donna Haraway, who commented critically on the construction of powerful scientific knowledge, feminists have challenged the truth claims of detached disembodied means of knowing the world. Haraway argued for a situated knowledge, referring to the notion that knowledge can be partial, located, and embodied; in other words, knowledge always comes from someone somewhere.[57]

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[51] Phil Brown. (1987).Popular Epidemiology: Community Response to Toxic Waste-Induced Disease in Woburn, Massachusetts. *Science, Technology & Human Values* 12(3/4): 78–85.

[52] Steven Epstein (1996) *Impure Science: AIDS, Activism and the Politics of Knowledge.* Berkeley: University of California Press.

[53] Ann Kerr, Sarah Cunningham-Burley, & Amanda Amos.(1998).The New Human Genetics: Mobilizing Lay Expertise. *Public Understanding of Science* 7(1): 41–60.

[54] Michael Bloor.(2000). The South Wales Miners Federation: Miners' Lung and the Instrumental Use of Expertise, 1900–1950. *Social Studies of Science* 30(1): 125–40.

[55] Alan Irwin et.al.(1999). Faulty Environments and Risk Reasoning: The Local Understanding of Industrial Hazards. *Environment and Planning A* 31: 1311–26.

[56] Irwin, A. (2001). *Sociology and the Environment: A Critical Introduction to Society, Nature and Knowledge.* Cambridge: Polity Press.

Science draw its impartial and deeply authoritative character because of what Haraway called the ‘God trick’ of seeing everything from nowhere and the refusal to situate claims relative to personal, social, and geographic contexts. Whereas scientific and other ‘master’ knowledges are founded on claims of universality created through supposed objective detachment, feminist researchers argue that situating knowledge enables more critical thinking. This placelessness is the characteristic of the global scale in climate change literature. This perhaps explains why astronauts in space are thought to be the best spokespersons for climate change narratives informed by climate science. It is, in essence, the placelessness provided by their privileged position from a great distance and lacking in intimacy with the immediate and the situated on planet earth that seems to admirably then qualify them to speak for the scientific narrative on climate change.

Haraway argues that the goal of situated knowledge is to have an earth wide network of connections, including the ability to partially translate the knowledges among very different and power differentiated communities. This conceptualization, arguably, almost mirrors Humboldt’s ideas on the need for a ‘natural whole’, by focusing on networks of connections for drawing larger implications.

Situated knowledge is thus not a passive or secondary body of non-factual expertise it is a conceptual framework to engage with knowledge beyond the scientific and non-scientific divide. It is a form of objectivity that accounts for both the agency of the knowledge producer and the object of study. Haraway argues that the idea of situated knowledge emerges from the challenge faced by feminist studies: How to have simultaneously an account of all knowledge claims (including the sciences) of knowing subjects and a no non-sense commitment to an account of ‘real’ world?[58]

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[57] Warf, B. (Ed.). (2006). *Encyclopedia of human geography*. Sage Publications.p.430.
[58] Donna Haraway.(1988). Situated knowledges: The science question in feminism and the privilege of partial perspective. *Feminist Studies* 14(3):575-599.

Challenge of dealing with climate and weather simultaneously

The immediate challenge of talking about climate in everyday life is the divide between climate and weather. Climate science which forms the basis of our understanding of climate change does not have a ready audience on the ground. On the other hand weather science which is referred to in everyday use has little to say about the changing climate. So the immediate challenge when studying climate change locally was how to engage with the sciences. Here I provide a substantial quote of Paul N. Edwards to highlight the established difference between climate and weather:

> In the short term (hours to weeks), such pattern are experienced as weather: rain, dry spells, clouds, hurricanes. Long-term patterns (occurring over months to decades and beyond) are known as climate, and include such phenomena as the seasons, with their regular annual changes in temperature and precipitation; prevailing regional climates (deserts, tropics, ice caps and so forth); multilayer climatic variations (droughts, the El Nino/ Southern Oscillation, and so on); and very long term climate changes such as ice ages.[59]

The emphasis on this difference was repeatedly reiterated by climate scientists and meteorologists during the field work for this study. When dealing with sciences the challenge was to find the characteristic or feature which was common to climate and weather science irrespective of the spatial and temporal differences. The feature identified as the connecting thread was the idea of ‘normal’. Climate scientists, meteorologists, coffee growers and insurers all identify ‘normal’ weather event informed by their respective perceptions. The idea of ‘normal’ rainfall is discussed in detail in chapter 4.

[59] Paul N. Edwards. (2001). Representing the Global Atmosphere: Computer models, Data and Knowledge about Climate Change in *Changing the Atmosphere: Expert Knowledge and Environmental Governance* (ed) by Clark A. Miller and Paul N. Edwards .MA:MIT Press: 36.

Rethinking adaptation: the research ideas

Scale discordance[60] is one of the biggest challenges in thinking through adaptation strategies for climate change. While global climate change is defined as a problem of high GHG concentration and increased global temperatures adaptation is inherently a concept which is designed to address a local context. Literature on climate change adaptation is unequivocal in identifying the concepts origin in evolutionary biology wherein an organism evolves along with the changing environmental conditions to maintain the fit that is required for sustaining life.[61] Commenting on this conceptual re-purposing — from evolutionary biology to climate change adaptation — Bassett and Fogelmen argue that the Intergovernmental Panel on Climate Change (IPCC) nonetheless still operates with an old-fashioned notion of adaptation as being ‘adjustment to climate stimuli’.[62] This re-purposing of adaptation from evolutionary biology to the climate policy domain has arguably not been smooth and unproblematic.

Even though the term adaptation found a mention in the first IPCC assessment report (1990), credible discussion only began much later with the first policy milestone for adaptation being reached in 2001 at the Conference of Parties (COP) 7 in Marrakesh. The COP 7 (2001) established the Least Developed Country (LDC) work programme which focused on the National Adaptation Programme for Action (NAPA). Subsequently in 2006, at the COP 12 in Nairobi the Subsidiary Body for Scientific and Technological

[60] Scale discordance is defined as a mismatch when available scientific information does not reflect the unique context of the environmental conditions and/or the geographic scale of decision making.

[61] Michael. J. Watts (2015). Now and then:The origins of political ecology and the rebirth of adaptation as a form of thought. In *The Routledge Handbook of Political Ecology*,19-50, Routledge London.P.3.

[62] Thomas J Basset and Charles Fogelman. (2012). Deja Vueor something new? The adaptation concept in the climate change literature. *Geoforum* 48:42-53.

Advice (SBSTA) was finally mandated to undertake a five year project to access how vulnerability and adaptation policies could be designed in relation to climate change. More significantly, the Cancun Adaptation Plan (CAP) was established at COP16 in 2010.[63]

Despite these significant policy milestones having been achieved in international negotiations alongside a growing body of credible literature on climate change adaptation[64], most of the work starts with a disclaimer in one form or the other stating that the very meaning of 'adaptation' is still not clearly understood and agreed upon.[65] Following excerpts from different studies highlight this:

> Although adaptation is frequently referred to in scholarly work policy discussions related to climate there is no common understanding of what is meant by the term, let alone how the prospects for adaptation might best be analyzed.[66]

> While definitions of adaptation abound, they have not been particularly helpful in building an understanding of what adaptation really entails.[67]

> Adaptation is necessary if we are to manage the risks posed by climate change. What we know about adaptation, however, is limited.[68]

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[63] Anshu Ogra. (2015). What do we talk about when we talk about adaptation to climate change. *Climate Eye.*http://www.climateeye.com/?p=638 (4/11/2016).

[64] Jesse Ribot. (2011). Vulnerability before adaptation: Toward transformative climate action. *Global Environmental Change*. 21(4): 1160-1162.

[65] Doria, M. D. F., Boyd, E., Tompkins, E. L., and Adger, W. N. (2009). Using expert elicitation to define successful adaptation to climate change. *Environ. Sci. Policy* 12, 810–819.

[66] John Smithers & Barry Smit. (1997). Human adaptation to climatic variability and change. *Global Environmental Change* 7(2): P.130.

[67] Heather McGray et.al. (2007). Weathering the storm: Options for framing adaptation and development. *World Resources Institute, Washington, DC, 57*.

Although there are a few guiding definitions of adaptation provided by various institutions, doubts continue to haunt these definitions. Some of the common definitions of adaptation to climate change are mentioned in the table given below.

Table 4: Definitions of adaptation to climate change.

Source	**Definition**
Intergovernmental Panel on Climate Change	Adaptation is an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory, autonomous and planned adaptation.[69].
United Nations Framework Convention on Climate Change	Adaptation refers to adjustments in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts. It refers to changes in processes, practices, and structures to moderate potential damages or to benefit from opportunities associated with climate change.[70].
United nations Development Programme	Adaptation is a process by which strategies to moderate, cope with and take advantage of the consequences of climatic events are enhanced, developed, or implemented (UNDP, 2005).
United Kingdom Climate Impacts Program	Adaptation is a process or outcome of a process that leads to a reduction in harm or risk of harm, or realization of benefits, associated with climate variability and climate change. (UKCIP, 2003)

[68] James. D. Ford et.al (2011). A systematic review of observed climate change adaptation in developed nations. *Climatic change* 106 (2): 327.

[69] IPCC (2014): Annex II: Glossary [Mach, K.J., S. Planton and C. von Stechow (eds.)]. In: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, P.2

[70]United Nations Framework Convention on Climate Change http://unfccc.int/focus/adaptation/items/6999.php (4/11/2016)

Source: The source of definitions has been cited alongside

The key words used for defining adaptation are ‘process’, ‘outcome’ and ‘adjustment’. A 2006 study by the Organization for Economic Cooperation and Development (OECD) argues that expectations from a successful adaptation strategy are different when it is looked at as a process and different when it is seen as an outcome.[71] These awkward attempts at grappling with adaptation as a policy response are perhaps indicative of a continuing lack of conceptual clarity. That is, essentially, it remains to be understood whether the success of the adaptation policy is to achieve a different state of equilibrium, a quick fix of an immediate concern or a tangible outcome like mitigation.

In this thesis we take adaptation out of its evolutionary biology moorings in order engage with it anew by using the conceptual tools offered by Science Technology Studies (STS). In particular, investigating how adaptation policies produce various kinds of authoritative knowledge and how the idea of adaptation is now being deployed in policy, politics and social organizations. It provides the possibility to rework boundary conditions which while maintaining the integrity of scientific knowledge can also seek to incorporate aspects of everyday experiences.[72,73]

This PhD thesis discusses three different perceptions over the ‘meaning’ of rainfall with regard to coffee production in the Western Ghats region in South India. The three perceptions that I refer to and discuss are those framed by: a) coffee growers b) meteorologists and c) insurers. Growers’ perception takes precedence in discussion

[71] Ellina Levina & Dennis Tirpak. (2006). Adaptation to climate change. Key Terms. Draft paper, Agenda Document 1, OECD/IEA Project for the Annex I Expert Group on the UNFCCC, P. 5 https://www.oecd.org/env/cc/36278739.pdf (4/11/2016).

[72] Peter Dear & Sheila Jasanoff . (2010). Dismantling boundaries in science and technology studies. *Isis*. 101(4):759-774.

[73] Sheila Jasanoff. (1999). STS and Public Policy: Getting Beyond Deconstruction. *Science, Technology & Society* 4(1): 59–72.

because the rainfalls identified for observation and monitoring are the ones which are crucial to understanding the coffee crop cycle.

Main research questions

Q1. How does rainfall which occurs over a defined geographic location at a specific time get differently measured, understood and valued by coffee growers, meteorologists and insurers? How do these groups conceptualize ‘normal’ rainfall, respectively?

Q2. How do coffee growers’ situated experiences of handling rainfall variability on their estates grapple with and factor in adaptation strategies to address rainfall variation such as artificial irrigation and insurance?

Q3. How do meteorologically determined rainfall forecasts get translated and interpreted by coffee growers for decision-making on the ground?

Q4. Do the coffee growers’ situated experiences of responding to local rainfall within their estates mark a different understanding from the meteorological and insurers exercise for downscaling rainfall impacts through a wider network of rain-gauges?

Q5. What challenge do these different perceptions of rainfall pose for conceptualizing climate change adaptation strategies?

Chapter 3

On a Coffee Trail: Fieldwork methodology

This chapter discusses aspects of my field work and the ethnographic methods and styles that I used for pursuing my research questions.[1,2,3,4] The main ethnographic methodologies were oriented to document, explore and examine the everyday experiences of coffee growers with regard to how the latter perceived weather events and rainfall variations. I also sought to layer and contrast my understanding of this notion of weather at the level of the 'everyday' by collecting a range of narratives about weather events generated by meteorologists and insurers. I sought to document and understand these technically and scientifically informed narratives about weather and rainfall through interviews (structured and open ended) of meteorologists and insurers and by a rough and ready participant-observation approach during visits to meteorological research stations and insurance offices.

Living on a plantation[5]

> 'The Flood', as it came to be called by the planters till they left India's shores, was, for them, 'the epitome of the isolation they experienced every monsoon, when mist and driving rain blotted out the surrounding hills,

[1] Karen O' Reilly. (2005). *Ethnographic Methods.*New York: Routledge: 114

[2] D. M. Fetterman, (Ed.). (2010). *Ethnography: Step-by-step* (Vol. 17). Sage.

[3] M.Agar. (1980). *The Professional Stranger.* New York: Academic Press.

[4] P. Atkinson., & M. Hammersley. (2007). *Ethnography: Principles in practice.* New York: Routledge.

[5] The word 'plantation' has been used in the thesis to refer to coffee farms in 19th century literature. Contemporary coffee farms have been referred to as 'coffee estates'.

> when gales hurled trees across the road, and blew down the telegraph lines, cutting their fragile communications with the outside world.[6]

In this excerpt from *Above the Heron's Pool* Lovatt describes the historic flood of 1924 in the Western Ghats region when 'Peermade (a hill station located in the Western Ghats range in Kerala state) got 350 inches of rain in one monsoon season itself. That July saw a record of 145 inches of rain of which 81 inches were received in barely a burst of a week.'[7] Lovatt captures the lived experience of this flood by focusing on an emotion which perhaps anyone who has ever lived on a plantation is familiar with: the experience of isolation. By using this all pervasive emotion as currency, he conveys how difficult it was to live through a flood which became an 'epitome of isolation'.

This 'experience of isolation' is central to the way a coffee estate shapes the life of those who come to live on it. Biographies of British planters are full of stories about struggles to seek comradeship amongst their own after weeks of separation in monotonous clearings of coffee plants surrounded by dense jungle. In retrospect, my own struggle to seek the comfort of company in order to face the stress of being alone in a new environment, perhaps also made me think like a coffee grower, in a manner of speaking. Here I use this currency of isolation as the central theme to help weave my own narrative about conducting field work in environments and societies that are starkly different from the city of Delhi, where I live.

It's all very well, to set off on a train telling yourself that you are quite brave and an adventurous person and will deal capably with things as they happen. But when you do actually arrive at the other end with no one to meet, you face the first challenge of the journey: test of your faith in the idea that put you on this path. It suddenly appears much more attractive to be at home reading some more books, digging out archival material

[6] From Heather Lovatt and Peter De Jong (1993), *Above the Heron's Pool: Short story of Peermade/Vandiperyar District of Tranvancore* cited in S. Muthiah (1993), *A Planting Century: the first hundred years of The United Planters' Association of Southern India.* Madras:Affiliated East West Press Ltd: p.42.

[7] Ibid, p.42.

and thinking about 'smarter' and less demanding ways (read online surveys) of doing things.

Robert H. Elliot, the pioneer planter who 'opened' the jungles of *Manzarabad* (now known as *Sakleshpur*), probably experienced, I think, this sudden similar loss of the familiar back in 1856. He writes how the civilized life of a city offered a comfortable and predictable monotony which was in sharp contrast with the life of a planter for whom unpredictable challenges were always just around the corner. He goes on to add that the desire to return to the former were extremely strong.[8]

> Now that I had fairly settled down and the novelty of situation had in some measure worn off, I began to experience some of the drawbacks and annoyance of the life I had selected – the greatest was of course isolation from any white faces. For weeks together I had often no opportunity of speaking my own language, and so rare was a European vision, that when one of the three White neighbors found time to pay me a visit, I used to sit up on a hill near my house and watch for his arrival as for a sail at sea.[9]

Close to 155 years since Elliot on 23 November, 2011, I too arrived at the same place and found myself struggling with a somewhat similar challenge. This sense of isolation turned, on reflection, perhaps to be extremely crucial in shaping the planters' sense and idea of community. Faced with the immediate problem of making a profit, S. Muthiah writes, planters were cagey, cautious and specially feeling vulnerable; the uncertainty of the industry, for example, made them unwilling to reveal details of their planting activities to their fellows. So while the rules required them to keep the planting ideas locked in their heads, the need to address the pain of isolation often brought them

[8] Robert. H Elliot (1871), *The Experiences of a Planter in the Jungles of Mysore*, Chapman and Hill, Piccadilly: London.p.18.
https://archive.org/stream/experiencesapla00elligoog#page/n6/mode/2up (29/12/2016).

[9] Ibid., p. 11.

together.[10] The initial get-togethers, which paved way for the formation of associations and clubs, were for the gregarious sociability that goes with meeting fellow beings after a spell of isolation without having discussions on planting matters.

In order to belong where I had arrived I too keenly sought the comfort of company. Every evening I found myself drawn to the warm, cozy and homely atmosphere of the kitchen. Here women folk would listen to my stories and share their own concerns. During those moments I was not an independent researcher moving around on my own, I seemed to be part of their family. I was not recording their concerns: rather it felt as though I was living these shared moments with them. Both the beginnings of these informal and loose associations through kitchen conversations and my own need for sociability would turn out to be crucial in shaping my engagement in the field.

Climate change and coffee growers: setting the context

An ethnographic approach to the field argues that human societies cannot be studied in the same way as natural sciences. The focus is on relationships, teasing detail from conversations, observing the unfamiliar with great care and being able to think in narrative styles. The first step in this exercise, as I saw it, was to set up the larger conceptual context for getting coffee growers to explain how they distinguished between decision-making for everyday weather and what they assumed to be preparations for dealing with climate change impacts.

[10] S. Muthiah (1993), *A Planting Century: the first hundred years of The United Planters' Association of Southern India*, (Madras:Affiliated East West Press Ltd.), p.169-170.

26 November 2011, 6.30 a.m, Sakleshpur, Hassan District, Karnataka[11]

Today, a number of coffee growers gather at a meeting point in town and leave for the *Baba Budan Giri* hill in busses and cars. Baba Budan Giri is a high hill in the *Dattagiri* Range of the Western Ghats of India. It is of historical importance to South Indian coffee growers. It is believed that Baba Budan, a Sufi saint, sometime during the 1600s smuggled out seven coffee seeds from Ethiopia by, as the story goes, taping them to his stomach and upon arriving at the Baba Budan hill successfully cultivated them there. This hill is approximately 100 kms from Sakleshpur.

Today growers are moving towards Baba Budan Giri to mark the commencement of the 550 km long walk from Baba Budangiri to Mangalore.[12] The purpose of this walk was to spread awareness about the impact of climate change in the coffee growing region. This degree of awareness and concern amongst South Indian coffee growers for an issue whose implications are generally depicted as involving the rise in sea level or melting of glaciers was, for me, striking.

Picture 5: Coffee growers at the inauguration of climate walk at Baba Budan Giri, Chikmaglur.

[11] Sakleshpura, initially known as Manazarabad, is one of the 8 taluks located in Hassan District of South Indian State Karnataka Sakeshpur is the first town I visited during my field work. Detailed discussions about this town are given the next section.

[12] The walk was organized by Karnataka Growers' Federation and Bengaluru based NGO Centre for Social Markets (CSM).

Coffee growers are a highly informed community and ensure that they are well connected with the larger world through newspapers, television, internet and mobile devices. They are aware of the climate change narrative i.e. it being an issue of increased concentration of greenhouse gases like carbon-di-oxide resulting in increased global temperatures. For most of the growers, I spoke to, responding to climate change impacts required efforts to sustain the forest cover in their plantations. Thus many believed that they needed to be compensated for such conservation efforts. Surprisingly, along with climate change, the notion of 'carbon credit' was also a concept that they were not only familiar with but keen to harness for its perceived financial opportunities.

In the middle of the all these important conversations about climate change and carbon credits my questions about local indicators of weather change did not always evoke their interest. Some growers, nonetheless, did recall stories about 'ants crossing the field' and 'birds flying near the pond surface' as indications of approaching rains. The indicators, however, it was clear were not followed for making cultivation decisions on the ground.

While conversations about climate change sounded distant, concerns for weather at the local level were felt to be immediate and part of everyday life. Stories about weather events especially rainfall figured prominently in association memoirs and informal gatherings.[13] Concerns for rainfall were an active component of decision making on the field. Each coffee grower individually monitored and recorded rainfall within their respective plantations. The rainfall records in some cases went back to as early as the 1900s.[14]

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[13] See annexure 15 for rainfall stories from coffee estates.

[14] See annexure 20 for sample rainfall data gathered from coffee estates.

Picture 6: Rainguage installed by a grower at his estate. Picture is taken in Saklespur, Karnataka

Picture 7: Rainguage installed by a grower at his estate. Picture is taken at Palini Hills.

The practice of maintaining rainfall records came from the British planters. There have been detailed works associating the history of coffee plantations with the spread of colonization.[15] Coffee plantation production which refers to a 'large centrally operated estate which is usually mono- cultured and is operated by hired workers' was

[15] Edgar T. Thompson(1932), *The Plantation,* University of Chicago, New material (2010), University of South Carolina.

undoubtedly introduced by the Britsh in South India.[16] But there are historical records which prove that the 'Natives' were engaged in coffee production and trade even before the British arrived. S. Muthiah in his work *A Planting Century* writes:

> Wild coffee appears to have been found as far south as the Wynaad in what is northern Kerala today, but its growth and records indicate, was best in the hills of Mysore. In fact, so well did the coffee grow that it was listed among the 'jungle produce' of Mysore and was on sale in the markets of Bengalore and Seringapatam by 1800.[17]

As yet, very few records exist which describe the cultivation practices of coffee growing prior to the arrival of the British in South India. But the handful of available records does indicate that much of the coffee was grown in backyards and gardens of the houses. About the cultivation practices of these 'Natives' the Officiating Superintendent of Nugur Division wrote in 1865:

> Having once put down their plants, they take no further trouble with them, but just pick whatever crop providence sends them and the monkeys leave, or more commonly, they sell it on the trees to anyone who will take the trouble to pick it. They possess large tracts of forest, the returns from which are miserably small.[18]

Much, in fact, to the surprise of several European planters, however, these so called 'Native planters' with their 'unplanned ways' of growing coffee were nonetheless

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[16] Uma Devi, *Plantation Economies of the Third World*, Himalaya Publishing House: Bombay (1989), p.3.

[17] S. Muthiah, *A Planting Century: the first hundred years of The United Planters' Association of Southern India*, (Madras: Affiliated East West Press Ltd,1993), p.6.

[18] Archival letter: From Mr. L. Bowring, Esq., Commissioner for the Government of the Territories of his Highness the maharaja of Mysore, to the Hon'ble W. Muir, C.S. Secretary to Government of India, Foreign Department, with the Governor General, Headquarters Shimla,-No. 1176-49, dated Bengaluru, the 4th July 1865.

producing more than them. In a Memorandum dated 20th October 1859, M. Cubbon, Commissioner Mysore observed:

> What the European planters will ever grow is nothing to the quantities produced by the Natives in their holes and corners and out of the way jungles.[19]

On the contrary the European planters who were directly involved in exporting their crops were very particular about their output and meticulous about their cultivation practices on the ground. In a Memorandum (27th June 1865) C.Veejea Rungum, a Head Sharistadar describes a European coffee planter in the following lines.

> From the moment that he commences his agricultural operations, spares neither expense nor labour, but unremittingly employs himself in his work, laying out his money with so niggardly and for a space of five years without realizing a single pie in return for the heavy capital he has invested; and the result of this steady perseverance and hence expenditure is that a thick impenetrable jungle is converted into a flourishing and well regulated coffee estate.[20]

The output oriented European coffee planters were undoubtedly aware of the crucial importance of regional climates and weather behavior in altering the coffee crop. In their biographies European coffee planters often noted how they managed the local climatic conditions.

> He must not locate himself in the shadeless torrid zone, swept by parching winds, or the first hot spell after the trees have come to maturity will wither their leaves and hopes at the same time. If he goes high up the

[19] Archival Letter: M.Cubbon (30th September 1859), Memorandum by Commissioner of Mysore and Coorg on cultivation of Coffee in those territories, File No. 129; 131 FC :3.

[20] Memorandum from Veejea Rungum, Head Sharistadar- No.50, Bangalore, the 29th June 1865 to Foreign Department August 1865, 4-6, Revnue A. p.7.

> mountains amongst the drifting clouds, he will get into a climate wetter and even colder than the English, and will possess in the fullness of time a garden admirably suited for producing the ingredients for coffee-leaf tea, but little else. He may be fond of sea view, but must remember that sea winds are laden with over much moisture, while those from the land are usually deficient in that very respect. To strike the happy mean between extreme adverse points, and to modify nature where he cannot control her, is half the planter's art.[21]

The European planters in order to strike the 'happy mean' continuously learnt to hedge and negotiate with weather variability. For example H.C.P. Hull mentioned how locating the right slope was essential in order to neutralize the effect of excessive rainfall;[22] Elliot emphasized on the importance of shade in counteracting the force and nature of winds beating upon the ground;[23]Arnold discussed how locating a plantation at a right height above the sea level could help overcome the effects of heat and dryness.[24]

My review of archival material carried out at the Nehru Memorial Museum and Library (New Delhi) and at the Karnataka State Archives, Vikasa Souda in Bengaluru, in fact, helped me track and map a range of such cultivating practices and strategies by

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[21] Edwin Lester Arnold. (1887). *Coffee: Its cultivation and Profit.* London: The Charter House Press :34 from: http://www.archive.org/stream/coffeeitscultiva00arnorich#page/34/mode/2up (28-1-14).

[22] H.C.P. Hull (1877), *Coffee Planting in Southern India and Cylon*, E & F.N. Spon, Charing Cross: London 42. https://archive.org/stream/coffeeplantingin00hullrich#page/n7/mode/2up (28/1/14).

[23] Robert. H Elliot (1871), *The Experiences of a Planter in the Jungles of Mysore*, Chapman and Hill, Piccadilly: London. https://archive.org/stream/experiencesapla00elligoog#page/n6/mode/2up. (28/1/14)

[24] Edwin Lester Arnold (1881), On the Indian Hills: Coffee Planting in Southern India, Sampson Low, Marston, Searle and Rivington: London. https://archive.org/stream/onindianhillsorc01arnoiala#page/n3/mode/2up. (28/1/14)

European planters. In particular, the manner in which they discussed and sought to understand weather variability as being a key aspect of coffee growing.[25]

Planter and grower: the social structure and configuration of the study group

Coffee grower as opposed to the planter is a new term, which was introduced relatively recently in South India. On the field I came across both these terms and I specifically used the term 'grower' in my thesis title. In a broad sense, it appears that these terms refer to the acreage of the land owned. However, it turned out that the terms had deeper implications as well. They were indicative of difference in how plantations were approached and engaged with. These engagements in turn informed the concerns around which coffee associations were created.

During the field work I came across three prominent associations: United Planters' Association of South India (UPASI), Karnataka Planters' Association (KPA) and Karnataka Growers' Federation (KGF). Of the three, it is the UPASI which is considered to bear the colonial legacy of the planting community. UPASI was established in 1895. It is an umbrella association that proudly represents the colonial heritage with which many coffee estates are generally associated. There are 3 state planters' association and 13 district planters' association which are affiliated to UPASI. KPA is one of its affiliated associations.[26] Karnataka has mainly coffee plantations therefore KPA is largely considered as the coffee wing of the UPASI.

KGF on the other hand is a relatively new association, which gained visibility only around 1993. It is represented by the diverse membership and support from small coffee growers across Karnataka. Its association membership is spread across the three coffee growing districts in Karnataka: Chikmaglur, Hassan and Kodagu: comprising- 9

[25] Many thanks to Dr. Rohan D' Souza for sharing some of the archival material on coffee.

[26] For detailed list of UPASI's member associations see annexure 9.

associations from Chikmaglur, 31 associations from Hassan, Sakleshpur and 21 associations from Kodagu.[27]

Arguably, KGF was established in response to the strong British character and colonial way of working inherited by the old associations like KPA and UPASI. KGF intends to erase the prevailing public impression that all the coffee growers are big land lords with imposing behavior and attitude. According to association documents they represent the mood, attitude and aspiration of 98.5% of coffee growers who have less than 10 ha of land area and whose concerns are no different than any other farmer of the country. The use of the word 'grower' instead of 'planter' is indicative of its inclusive and revolutionary approach.

Here a couple of things need to be flagged:

a) KGF and UPASI (which includes KPA) both have large as well as small estate holder as their members. Small growers take UPASI membership for

i) learning about the new development in coffee industry.

ii) and also for the social status that comes along with its membership.

Growers with large land acreage, though not all, have become part of KGF to harness political gains for personal as well as professional purposes by drawing on the extensive local reach and support this association has.

b) In this work usage of the term 'grower' is not suggestive of coffee producers' land acreage rather it is indicative of the struggle that connects coffee producers across the scale: the struggle to strike a balance between treating coffee estates as a farming unit and as a business enterprise.

The marked difference in the working style of these associations is reflected in how they engage with Coffee Board. Coffee Board is the main government organization

[27] For detailed list of KGF's member associations see annexure 8.

overseeing the coffee industry. It was established by the Central Government under the administrative control of Ministry of Commerce and Industry. While UPASI has a negotiation based approach KGF has an activists' approach. KGF's emergence coincides with an important event in the Indian coffee market which was to substantially change the role of Coffee Board: liberalization.

Under the constitutional Act 'Coffee Act of 1942', through which the Coffee Board was constituted, all estates were to be registered. Growers had to surrender their entire produce to the Board who then arranged for the sale. In the late 1980s, however, major changes in the international coffee market lead to the sharp decline of world coffee prices. These events prompted small and medium sized growers to join forces with UPASI to demand that the market in India be liberalized.[28] It was during this long process of liberalization of the Indian coffee market which stretched from 1992 to 1996 that the KGF gained visibility.

First round of field work (4 November 2011 to 4 January 2012): entry

David M. Fetterman in his work *Ethnography: step- by- step* argues that gaining entry in a culture through the right person is very important. Walking in a community randomly might have chilling impact for an ethnographic research. Community members might not be interested in individual ethnographer or the work. An intermediary, or a go between can open doors otherwise locked to an outsider.[29]

I made my initial forays in the field through the networks of Centre for Social Markets (CSM), KGF and Hassan Districts Planters' Association (HDPA). Both KGF and HDPA have their head office in Sakleshpur. I arrived in Sakleshpur town on 23rd November 2011. Sakleshpur is 220Kms from Bengaluru and Karnataka State Road Transport Corporation (KSRTC) bus covers this distance in about 7 hours. The town lies

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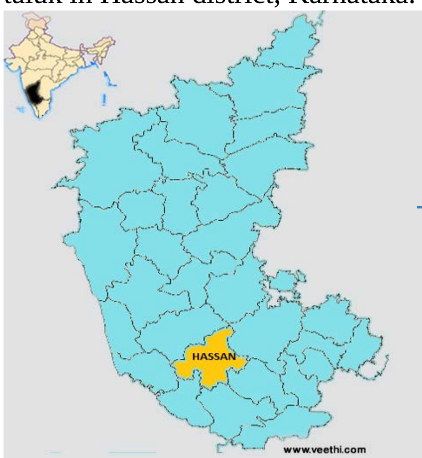
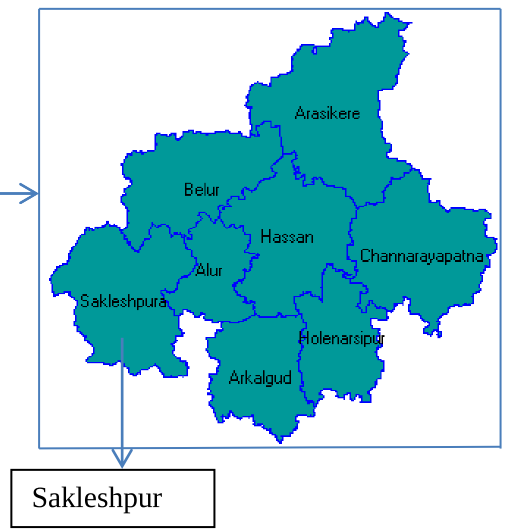
[28] Akiyama, A.,Baffes, J., Larson, D. F., & Varangis, P. (2001). *Commodity market reforms: lessons of two decades*. World Bank Publications.p.89.

[29] Fetterman, D. M. (Ed.). (2010). *Ethnography: Step-by-step* (Vol. 17). Sage. P. 36.

on a national highway which connects the port city of Mangalore with Bengaluru. Because of this strategic location bus service between Bengaluru and Sakleshpur is frequent.

Map 6 & Map 7 : Location of Hassan district in Karnataka state and Sakleshpur (Sakleshpura) taluk in Hassan district, Karnataka.





Source: Google images.

Hemavathi river, a tributary of the Kaveri, flows through the town. Though the town is easily accessible through the State transport bus service, movement within the taluk depends essentially on private vehicles. I found an accommodation in the town from where I travelled all over the taluk and the adjoining coffee growing districts of Chikmaglur and Kodagu. The average elevation of Sakleshpur taluk is 949 meters (3113 feet). This makes it suitable for growing both Arabica and Robusta coffee.

In everyday struggles local transport was one of the immediate challenges. Coffee estates were located far from the town. Locals travelled within the taluk by using private vehicles. For instance labour families who were living near the town and not at the estate were provided transport by the grower. To visit estates which were within 20 kms range of the town I hired a local taxi. This arrangement was reached with the help of locals because in small towns local taxis are not used to travelling such long distances.

For the estates which were still further away, I requested the host grower for the transportation and stay.

Fetterman argues that while selecting an integral and powerful member of the community is useful, but establishing independence is also important to avoid prematurely cutting off other lines of communication.[30] This required spending quality time in confidence-building exercises on the ground. Confidence building within growers' community was a slow exercise. Pivotal role in this exercise was played by: a) the coffee walk organized by KGF and Centre for Social Market (CSM), b)everyday visits to KGF and HDPA office c) regular visits to Women Coffee Promotion Council (WCPC) office d) attending coffee growers' weekly association meetings e) and also being part of growers' family get-togethers, local events and functions.

Picture 8 & Picture 9: Growers' association meetings in Ballupet and Sakleshpur respectively.

This round of the field work began with carrying out what Spradely and McCurdy called grand tour in ethnographic methods.[31] It constructed the basic map of the place and helped in defining the boundaries of the study in order to plan wise use of resources. This grand tour helped in organizing the thoughts and focusing and directing the investigation on the field toward the identified objectives.

[30] Fetterman, D. M. (Ed.). (2010). *Ethnography: Step-by-step* (Vol. 17). Sage. P.37

[31] Spradley, J. P., &McCurdy, D.W. (1989). *Anthropology: The cultural perspective.* New York: Waveland Press.

The interviews carried out during this round of field work were essentially semi-structured, informal and retrospective. After the initial week or two were spent establishing the larger picture and identifying the opportunities, a second ethnographic method was employed: participant observation. Participant observation combines participation in the lives of people under study with maintenance of a professional distance that allows adequate observation and recording of data.[32]

Two specific strategies: insurance and irrigation

Weather especially rainfall has always been a source of concern for coffee growers and it now appeared to have mixed with narratives about climate change. The very substantial noise that was now being generated about weather and climate, infact made it difficult to filter out growers' lived experience from the larger theories about climate change that were also floating around. As one of the grower mentioned in a candid moment during the interview

> Yes, we do worry about the performance of rainfall and other weather events but let's talk about something which can be fixed.[33]

For addressing this challenge I reframed my questionnaire to focus on coffee grower's everyday life. In this evolved set of discussions I was made aware of two specific strategies available to growers for addressing their concerns emerging from variation in rainfall: insurance and irrigation. Once the panoramic view of the community was gathered the focus was narrowed down to these two strategies.

Insurance was encountered on the field in the form of Rainfall Insurance Scheme for Coffee (RISC). RISC was introduced in 2007-08 by the Agriculture Insurance Company of India (AICI or AIC) in consultation with the Coffee Board for coffee growers in three traditional coffee growing South Indian states: Karnataka, Kerala and

[32] Powdermaker, H. (1966). *Stranger and friend: The way of an anthropologist.* New York: Norton.

[33] F.R.Abid, interviewed on 21/12/2011 at Arehalli Planters' association office, Arehalli, Belur taluk, Karnataka.

Tamil Nadu. It was in operation independently of any discussions on climate change. RISC is a type of Index Based Weather Insurance scheme (IBWI) or Weather Based Crop Insurance Scheme (WBCIS).

The essential feature of IBWI is that insurance contracts are meant to respond to objective parameters (e.g measurement of rainfall or temperature) at a defined weather station during an agreed time period. The parameters are set so as to correlate, as accurately as possible, with the loss of a specific crop type suffered by the policyholder. All policy holders within a defined area receive payouts based on the same contract and measurement at the same station, eliminating the need for in-field assessment.[34]

RISC was pursued for this study because as part of the socio-economic landscape it provided a ready template to compare growers' reaction to scientific definitions of normal and abnormal rainfall. While in simple descriptive account, saying that 'a few people liked the scheme and few other people didn't' may not be problematic but for research purposes establishing greater specificity is important. Choosing RISC as a policy measure to discuss larger changes in rainfall pattern, therefore, required the field work to be pushed in new a direction.

This new direction included exploring the connections between weather insurance and climate change. In this process I was introduced to State Action Plans on Climate Change (SAPCC). In 2009 the Government of India directed all the state governments and union territories to prepare State Action Plans on Climate Change (SAPCC).These state plans are now available on the website of Ministry of Environment, Forest and Climate Change (MoEFCC). Out of the 32 SAPCCs available online 23 explicitly

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[34] W. Dick., & A. Stoppa. (2011). Weather Index-Based Insurance in Agricultural Development: A Technical Guide. *International Fund for Agricultural Development (IFAD)*. P.18. https://www.ifad.org/documents/10180/2a2cf0b9-3ff9-4875-90ab-3f37c2218a90 (14/8/2016).

promote Weather Based Crop Insurance Scheme (WBCIS) or Index Based Weather Insurance Scheme (IBWI) as an adaptation strategy.[35,36,37]

To understand how indexing weather has qualified as an adaptation strategy for climate change, I conducted several detailed interviews with:

a) managers at AIC office in Delhi and Bengaluru;
b) telephonic interviews were conducted with insurance experts based in Mumbai;
c) managers at ICICI Lombard Delhi office,
d) Economists at National Centre for Agricultural Economics and Policy Research (NCAP) and International Water Management Institute in New Delhi.
e) Faculty and researchers at Centre for Policy Research (CPR).

This phase included interactions with faculty at Centre for Policy Research (CPR) and other interviews with insurance officials and academicians working on agriculture insurance policy. Engaging with the second strategy was equally challenging. This was artificial irrigation. Tracking artificial irrigation system provided inroads into understanding growers' decision making process while making financial investment in the field. Much like weather insurance, artificial irrigation also figure in State Action Plans on Climate Change (SAPCCs) as an adaptation strategy. For this reason these two strategies were picked up to discuss adaption to climate change even they, as flagged previously, they exist on the ground independent of any discussions on climate change. While decision making for artificial irrigation requires credible rainfall forecasts, insurance, on the other hand, is based upon statistical patterns about rainfall, which is

[35] For further details see Ministry of Environment, Forest and Climate Change (MoEFCC) website: http://www.moef.nic.in/ccd-sapcc (31/12/2016).

[36] Also see, Dubash, N. K., & Jogesh, A. (2014). From Margins to Mainstream? State Climate Change Planning in India. *Economic and Political Weekely* Vol XLIX (48) : 86-96.

[37] Anshu Ogra (2013): A Study of Climate Policy Integration in the State Action Plans on Climate Change, background paper produced for Centre for Policy Research, New Delhi.

generated by data from a network of rain gauges. Detailed discussions about these two strategies are provided in chapter 5.

Second round of field work (February - March 2014)

The first round of field work identified RISC and artificial irrigation as the two strategies driven by meteorological information about rainfall available to coffee growers for addressing their rainfall concerns. The second round of field work focused specifically on the institutional network of meteorological organizations which informed these two strategies. Earlier interviews at the Coffee Board office in Bengaluru had suggested that scientists at Central Coffee Research Institute (CCRI) played an important role in setting rainfall triggers for RISC. Central Coffee Research Institute is the research wing of the Coffee Board. It is located in Balehonnur, Chikmaglur and is approximately 295 Kms from Bengaluru.[38]

It carries out research in the disciplines of plant breeding and genetics, coffee agronomy, soil science and agricultural chemistry, plant physiology, plant pathology, entomology, post-harvest technology, coffee biotechnology and coffee quality. Coffee growers are continuously exploring new technologies for irrigation, harvesting and fighting infestation. They also pursue high yielding varieties, fertilizers and manures for better results. CCRI has one research sub-station in Chettali, Kodagu, Karnataka and it has four regional coffee research stations. In addition to CCRI headquarters I visited the Chettali research substation in Kodagu and Thandigudi regional research station on Tamil Nadu. These visits highlighted that each research station had a weather monitoring unit which recorded rainfall and temperature on everyday basis.

While tracing the institutional network that informed RISC I was lead to the Karnataka State Disaster Management Cell (KSNDMC) and Center for Mathematical Modeling and Computer Simulation (C-MMACS). KSNDMC was first established as Drought Monitoring Cell (DMC) in 1988. It had the distinction of being the first

[38] For more on CCRI refer to annexure 16.

institutional mechanism in the country to monitor droughts. Slowly its activities were broadened to include other natural disasters and it was finally renamed as the Karnataka State Natural Disaster Management Cell (KSNDMC) in 2007.

Monitoring drought was part of the primary as well the evolved mandate of the institute and in time it has become a robust network of Telemetric Rain Gauge (TRG) and Telemetric Weather stations (TWS) throughout Karnataka.[39] Moreover the institute is widening its TRG network and going upto the Gram Panchyat level under the Special Development Programme. Coffee Board and AIC uses this network of rain gauges to gather rainfall data. Their inputs are also sought by the Coffee Board to verify the probability of the rainfall triggers prescribed by AIC. For this purpose KSNDMC uses the services of the Center for Mathematical Modeling and Computer Simulation (C-MMACS).

C-MMACS now known as the Council for Scientific and Industrial Research's (CSIR) Fourth Paradigm Institute is the youngest and the smallest of CSIR laboratories. As the name suggests the lab was designed to carry out research in the field of mathematical modeling and computer simulation and offer their insights to other fields of research. The Centre is located in the Belur Campus of the National Aerospace Laboratories (NAL), Bengaluru. In total seven interviews were conducted at KSNDMC and C-MMACS which included scientists and statisticians working on weather and climate.

Rainfall forecast network: meteorologists and climate scientists

Detailed interviews were conducted with meteorologists at Indian Meteorological Department (IMD) office in Delhi, Bengaluru and Pune; climate scientists at Indian Institute of Tropical Management (IITM), Pune and scientists at National Centre for Medium Range Weather Forecasting (NCMRWF), Noida. For better organizing this chapter these interviews have been clubbed under the period of second round of field

[39] For detailed list of locations where RRG have been installed refer to annexure 17.

work, however, they were spread throughout 2014 and 2015. On the field IMD was one of the many sources of weather information used by coffee growers. More specifically growers showed interest in the satellite images produced by IMD and published in everyday newspaper.

There was a specific reason to pursue IMD network, for my work, even though growers showed equal, if not more, interest in other sources of weather information like accuweather.com, BBC weather information and weather forecast on news channels. IMD is not merely a weather information dissemination unit. It generates the information with the use of weather models, satellite images and Numerical Weather Prediction (NWP) tools. My primary interest was to understand how a particular weather event was comprehended by meteorologists and climate scientists. Hence I chose to engage with IMD.

Engaging with both meteorologists and climate scientists simultaneously turned out to be a challenge. Their space and time scale of working was different. The models they work with, their target audience and output was markedly different and there appeared to be no common ground from where I could engage with both the groups simultaneously. This simultaneous engagement was even more important for this study because while climate science engages with the challenge of climate change it is meteorology or weather science which has relevance in lived everyday life.

Investigating the point where climate and weather concerns in the scientific world overlap became the prime focus of the interviews. Pursuits of this answer lead me beyond the IMD Delhi and Bengaluru office and IITM Pune. I was introduced to NCMRWF in Noida and IMD Pune. While NCMRWF deals with both weather and climate modeling IMD Pune is where climatologists work. These interviews then paved way for understanding:

- How ‘normal’ for a particular weather event were arrived at?
- How do scientists declare that monsoons have arrived?

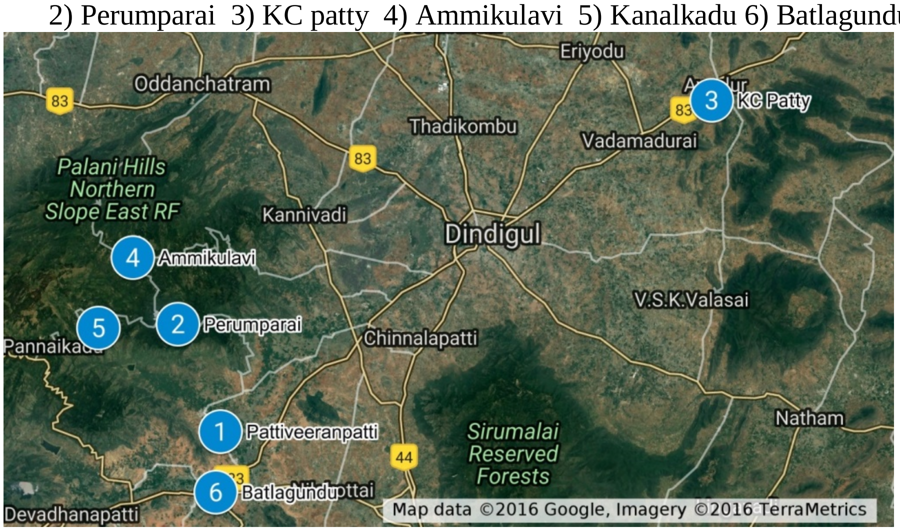
- How are normal and abnormal variation identified?
- How is it verified that a particular weather event like rainfall performed well or not?
- In summary, how a weather event is comprehended by meteorologists.

Apart from interviewing the scientist at KSNDMC and C-MMACS, 13 other climate scientists, climatologists and meteorologists were interviewed.[40]

Visit to Palini Hills

During the 2014 round of field work I visited a different coffee growing area: the Palini hill region in Dindigul district of Tamil Nadu. Palni hills are an eastward extension of the Western Ghats ranges. The hills start at 230 meters and rises upto 2300 meters. Palini hills are approximately 400 kms from Bengaluru. It receives rainfall mainly from North-East Monsoon. Under this rainfall regime the Palini region receives its maximum rainfall in the month of October. I stayed with a coffee grower's family at Pattiveeranpatti village.

Map 8: Location of villages where plantations were visited in Palini. These are 1) Pattiveeranpatti 2) Perumparai 3) KC patty 4) Ammikulavi 5) Kanalkadu 6) Batlagundu.



This area was approached through the networks of CSM and Palini Hills Conservation Council (PHCC). Palini hill coffee estates are characteristically different

[40] For details of the interviews refer to the annexure 2,3,4.

from the coffee estates in Karnataka. Here slopes are steeper and the estates are much smaller in acreage. The climatic conditions provided by higher elevation are suited only for Arabica. Being an essentially Arabica growing area, the 'traditional forest cover' is maintained. I, in fact, found the forest cover to be much thicker than the Karnataka belt.

Palini also has coconut plantations. As coffee is not it's primary crop, cultivation practices followed for other crops also affect the local ecology. For instance my visit coincided with a drought situation which was being experienced for the third year in a row. In order to address the challenge coconut growers had, extensively drawn ground water and were now even using the services of water tankers. Drawing upon ground water was allegedly having negative implications for coffee estates. However rains resumed within three days after I left. Growers whom I had interviewed wrote to me afterwards sharing their joy.

The coffee growers' rainfall experience in this region is unique for 3 reasons a) growers here follow the rhythms of the North- East Monsoon; b) irrigation is not feasible in this region because of elevation, terrain and Arabica variety of coffee and c) because of steeper terrain efforts to retain rainfall water is as critical a challenge as receiving timely rainfall.

Picture 10 & Picture 11: Palini hill plantations showing the steep slope with steps being carved out to move around the plantation.

Revisiting Sakleshpur coffee estates: blossom stage

During this round, three of the Sakleshpur coffee estates were revisited. The goals of revisiting these estates were two fold a) to capture the irrigation phase of the crop cycle b) to learn about the status of unseasonal rainfalls which growers reported in 2011.

Picture 12 & Picture 13:Robusta plantation in full blossom & irrigation being carried out using rain-guns

Third round of field work (January, February and March 2015): reciprocity

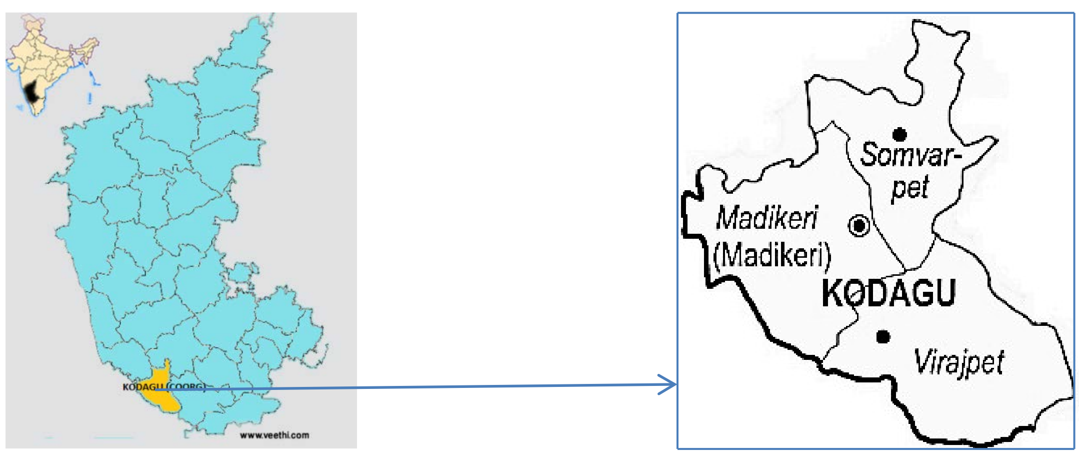
An ethnographic study requires a great deal of people's time and ethnographers owe something in return. The sense of reciprocity was the theme for the third round of field work. In this way, the third, last and longest part of the field work was characteristically different from all the preceding visits to the field. By 2015, I was already a familiar face in the growers' community. This time the challenge was not to establish myself on the field rather the challenge was to find out new questions of engagements with the field.

My initial visit drew growers' attention owing to the novelty of the situation (a woman travelling alone to the far off areas). By 2015 things had changed visibly for me. The old and new interviewees were interested to know what does the last four years of my work on coffee suggest so far. This time around I no longer felt like a silent observer or curious new entrant. I almost felt that I was an active participant whom they were equally interested in listening to. I began this time by presenting my work at three prominent association gatherings.

a) Karnataka Growers' Federation (KGF) General Body Meeting (GBM), 6th January, 2015, Kodava Samaj Hall, Somwarpet, North Kodagu. Approximately 100 growers attended the gathering 11 A.M.
b) Kodagu Jilla Coffee Belegarara Sangha meeting, 6th January 2015, VSSN Bank Building, Sunticoppa, Kodagu, Approximately 40 growers attended the meeting, 3 P.M.
c) Black Gold League Association workshop, 19th January 2015, Horticulture college Mudgere, Chikmaglur affiliated to University of Agriculture & Horticulture Sciences, Shimoga. 72 growers attended this meeting.

The first two presentations introduced me to the Somwarpet taluk of Kodagu district. Kodagu district has three taluks: Somwarpet, Medikeri and Virajpet.

Map 9 & Map 10 : Location of Kodagu district in Karnataka & taluks in the Kodagu district



Source: Google images.

Somwarpet is approximately 235 Kms from Bengaluru and KSRTC bus takes about 7 hours to cover this journey. I stayed with the Mahendra's family in Sunticoppa, Somwarpet and visited plantations in Biokere, Chetalli, Madapur and Medikere and also

Sunticoppa. Sunticoppa and other adjoining regions receive the rains from Allepey-Manglore regime i.e the South- West Monsoon. Maximum rainfall is received in the month of July and August. Somwarpet taluk has relatively a flat terrain. Detailed interviews were carried out with 7 coffee grower and 26 other coffee growers were interacted with during association gatherings.[41]

The third presentation was made during a growers' workshop being organized by Black Gold League (BGL). BGL is pepper growers training institute which was started by four progressive pepper growers in the year 2012 in Mudigere, Chikmaglur, Karnataka. Interestingly, pepper growers are also coffee growers and vice versa. Black pepper is a flowering vine in the family *Piperaceae*. The vine can easily grow on shade trees which are maintained in the coffee estates. Pepper, like coffee, is also a traded commodity. It grows well around the elevation of 900meters. Thus pepper cultivation needs shade trees and specific elevation.

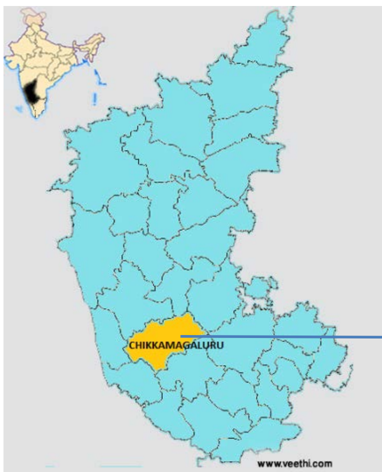
Picture 14: Pepper vines growing on shade trees in coffee plantation in Mudigere, Chikmaglur.

BGL's unique character brought together an interesting set of coffee growers. These growers were not from the same area neither did they belong to the same acreage

[41] For interview details see annexure 2,3 and 4.

group but they all had chosen to go beyond coffee and grow pepper. I was part of a one day workshop conducted by BGL at Horticulture college Mudigere in Chikmaglur. Mudigere is around 254 kms from Bengaluru. Bus takes about 7 to8 hours to cover this journey.

Map 11: Location of Mudigere taluk in Chikmaglur district. Map 12: Taluks in Chikmaglur district.



Source: Google images.

In the workshop I presented my work to an audience of 61 coffee growers. I carried out a written survey. The questionnaire and list of participants is attached in the annexure 11 & 5 respectively. The workshop included field visit to K.R. Keshava's estate. He is the chairman BGL group and a successful pepper grower. During the third round of field work, I went beyond the coffee growers community and presented my work to other audiences who engaged with coffee, insurance, and ecology of Western Ghats belt. These included:

1. Presentation on 13 February, 2015, Central Coffee Research Institute, Balehonnur, Chikmaglur, Karnataka. 16 scientists working on coffee attended the session. Afterwards they were asked to give their feedback.

2. Presentation on 18th March, 2015, Agriculture Insurance Company, Head office, Bengaluru. 8 officers who were currently working on RISC.
3. Presentation on 18th March, 2015, Indian Institute of Plantation Management (IIPM), Bengaluru. 15 faculty members attended this session.
4. Presentation on 6 February, 2015, Centre for Study of Science, Technology and Policy (CSTEP), Bengaluru.
5. Presentation on 23 September, 2015, 122nd Annual United Planters of South India (UPASI) conference, Connor, Tamil Nadu.

Articles were also contributed to growers' souvenirs and magazines in order to reach the larger audience in planting community. The goal of this exercise was to spread the word about this work so that a larger audience of growers could share their experiences of unprecedented variation in weather.[42] Additionally an online blog was also started to make the work accessible. The blog can be accesed at:http://anshuogra.blogspot.in/search?updated-max=2015-04-05T09:39:00-07:00&max-results=7 (22/1/2017) .

KPA, UPASI and the coffee business

During the third round of field work I pursued the KPA and UPASI association networks. Both these associations approach coffee estates as a business enterprise and considers its members as businessmen. This approach was visible in the KPA association meetings and during the individual interviews carried out with KPA and UPASI members. During this round of visits I also visited one of the Tata coffee estates in Kotte Betta, Kodagu. Interviewing KPA members automatically introduced me to the UPASI members. Interacting with UPASI members eventually paved way for presenting my work at 122 Annual United Planters Association of South India conference held in Connor, Tamil Nadu, India on 23-24 September 2015.

[42] For details about articles refer to annexure 18 and 19.

During this stage of field work I used unobtrusive methods in ethnography. Unobtrusive methods in ethnography were used to study the coffee market. Unobtrusive methods are the ones where ethnographer attempts to be as unobtrusive as possible in order to minimize the effects on participant's behavior. I used this technique to study the workings of the coffee market. Engaging with KPA and UPASI required thinking about coffee estates as business and coffee as a commodity. To gain better understanding of commodity chain I attended coffee auctions being conducted at the Coffee Board every Thursday. These auctions are being conducted by Indian Coffee Traders Association (ICTA). Very small quantities are sold through this auction where purchasing is done mainly by small or medium domestic roasters.

Picture 15: Coffee traders and roasters checking samples before the auction. Coffee Board office, Bengaluru.

Additionally, interviews were carried out with faculty at Indian Institute of Plantation Management (IIPM) in Bengaluru; managers at J.Thompson and Corporation Pvt. Ltd; Director, Forbes, Ewart & Figgis (P) Ltd; proprietors of small curing Units; managers at Mudre Mane Coffee Curing Unit.

Concluding remarks

In order to carry out field work that captures nuanced concepts like situated knowledge it was important to have tools which have the flexibility of modifying as per the challenges and requirements posed by the field. Ethnography provided this opportunity. Ethnography is about telling a credible, rigorous and authentic story. It gives voice to people in their own local context, typically relying on verbatim quotations and ‘thick’ description of events. The story is told through the lens of local people as they pursue their daily lives in their own communities. This approach to the field provided by ethnographic methods fitted perfectly with the research questions of the study.

The various ethnographic methods employed during these field study included: participant observation, structured and semi-structured interviews, informal interviews, surveys, grand-tour questions and retrospective interviews. Other sources used for collecting information included audio records, photographs, newspaper cuttings, texts, association publications, calendars, individual biographies and internet blog.

Following is a comprehensive overview of the areas covered during the field work. In a total time period of 7 months spanning from 2011-2015 I visited 2 states, 4 districts, 8 taluks and 41 villages. Detail interviews were carried out with 82 coffee growers, 61 other responded to a written set of questionnaire and 19 more were interacted with during association gatherings. 26 scientists working on climate and weather science were interviewed. 54 other interviews were carried out. These interviewees included Coffee Board Officials, coffee scientists, Coffee Board extension officers, insurance officials, coffee traders & roasters, Faculty at Indian Institute of Plantation Management, coffee tasters, journalists reporting about coffee, and others.

Table 5: List of states, districts, taluks and villages visited during the course of this study. Detailed list of all the interviews are attached in the annexure.

State	Karnataka			Tamil Nadu
District	Hassan	Chikmaglur	Kodagu	Dindigul
Taluk	Sakleshpur	Chikamglur	Somwarpet	Palani
Village	Halsulige	Javali	Somwarpet	Pattiveeranpatti
-do-	Sundekere	Kadavanthi	Kadavanthi	Perumparai
-do-	Kyamanhalli	Boggase	Sunticoppa	KC Patty
-do-	Hanbal	Handi	Chettali	Ammikulavi
-do-	Moogli	Mudigere	Boikeri	Kanalkadu
-do-	Bykere	Mudigere	Ibnivalvadi	Batlagundu
-do-	Sakleshpur town	Halase	Madapura	
-do-	Ballupet	Kenjige		
-do-	Chikkasathigala			
-do-	Annemahal			
District		Narasimhrajapura	Medikeri	
Village		Balehonnur	Medikeri	
District			Verajpet	
Village			Devarpura	
-do-			Pollibetta	
-do-			Kotte Betta	

Chapter 4

Everyday Politics of Climate Change: Defining 'normal' rainfall for growers, insurers and meteorologists

This chapter explores the idea of 'normal rainfall' by discussing how the three different perceptions (coffee growers, meteorologists and insurers) define the 'normal'.

> *This is my little empire, Uma, I made it. I took it from the jungle and moulded it into what I wanted it to be. Now that it's mine I take good care of it. Looking at it, you would think everything here is tame and domesticated, that all the parts have been fitted carefully together. But it's when you try to make the whole machine work that you discover that every bit of it is fighting back. It has nothing to do with me or right or wrongs: I could make it the best run kingdom in the world and it would still fight back.*[1]
>
> Amitav Ghosh

In the above lines, from the novel *The Glass Palace*, Amitav Ghosh insightfully captures the challenge inherent in caring for a plantation: the challenge of finding an order in the natural world which is reflected in the coffee growers' constant struggle with weather conditions which are beyond their control and must be accepted with joy or resignation as the case may be. Weather patterns, in fact, are critical to dictating the location where coffee can be produced in South India.

The climate prevailing in the coffee- growing regions in India may be largely described as 'sub- tropical' with a rainfall of something between 60 and 100 inches a year, divided into wet and dry season. Heavy rainfall is experienced during monsoons from June to September. The receding monsoon or the North-East monsoon brings showers from late September to early November. The moisture in the soil from the latter half of November-early to late March allows the crop to ripen during the dry months.

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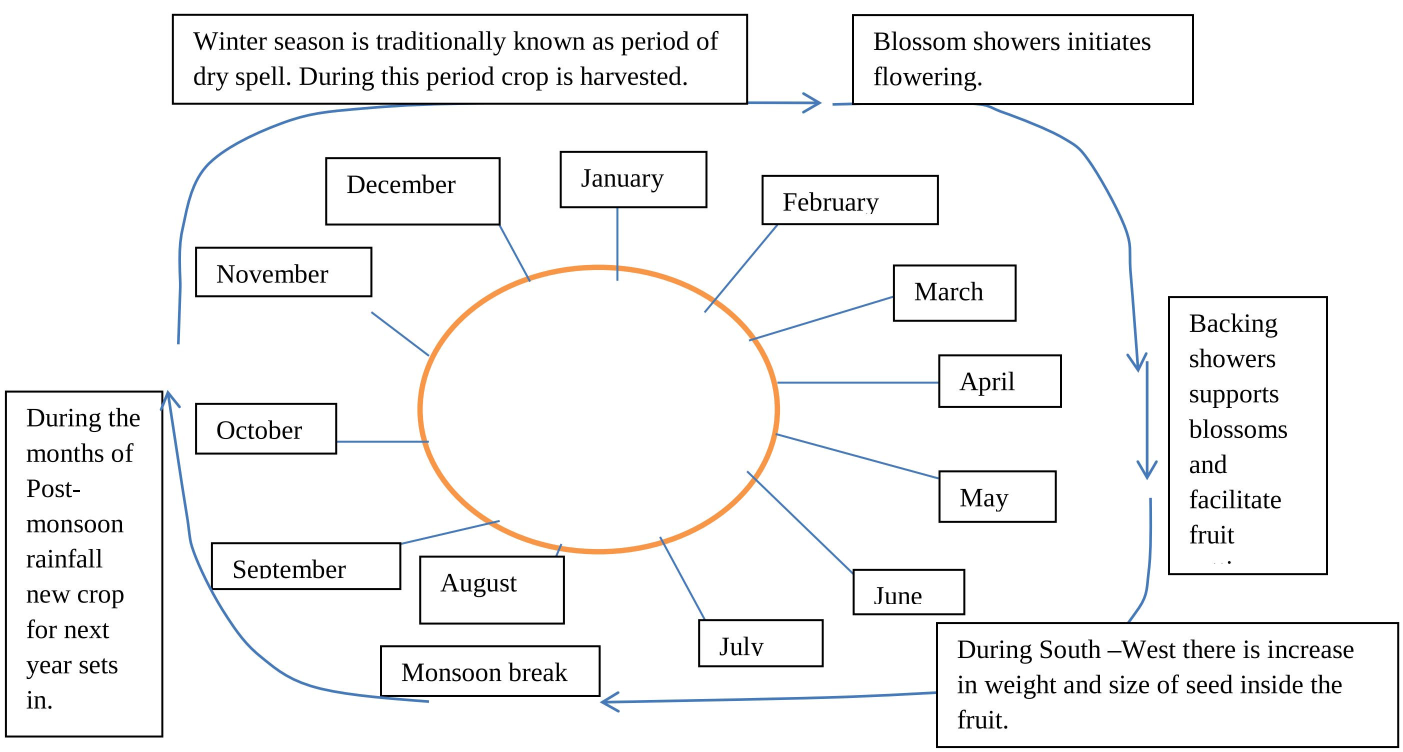
[1]Amitav Ghosh, *The Glass Palace*, Harper Collins publication: Uk (2000),p. 233.

During these dry months (November, December and January) the harvesting of the coffee is carried out. By the time the coffee bean begins to ripen on the plant, the soils are in fact in a very dry condition.

After the dry months, the first rainfall received during March and April is known as the 'blossom shower' or the *Revathi Malay*. The blossoms open overnight, when it looks as if the evergreen coffee had been covered with snow. Blossom showers are then followed by the 'backing showers', which enables pollination and fruit set before the arrival of heavy rainfall brought on by the South- West monsoon in June.[2] Outlined below is the diagrammatic representation of rainfall and coffee- crop cycle in South India.

Figure 1: Diagrammatic representation of coffee crop cycle in South India.



[2] R.O.Oliver .(1940).The coffee industry in India. *Journal of the Royal Society of Arts* 88(4569):823-841.

'Normal' rainfall for coffee grower

Joseph M. Walsh, a British planter, in a book published in 1894 underlines the 'paramount role of climate' in the shaping of the coffee crop. He writes 'the principal points that determine the value of location for successful and profitable cultivation of coffee are: a) soil and climate; b) situation and aspect[3]; c) temperature and rainfall; d) proximity to the river; e) shelter from wind and wash'.[4] In their biographies European coffee planters often keenly noted their experience of the regional climate and how within the range of natural factors that affected their crop they had to carefully distribute their risks.

These European planters always tried to strike the 'happy mean' by continuously balancing out one natural variable against the other. For example, a planter H.C.P. Hull mentioned how locating the right slope was essential in order to overcome the effects of excessive rainfall;[5] Elliot also emphasized on the importance of shade in counteracting the force and nature of winds beating upon the ground.[6] Another planter by the name of Arnold discussed how locating a plantation at a right height above the sea level could help minimize the effects of heat and dryness.[7] Even to this day, as evident from my field work, the cultural practices being followed on the contemporary coffee estates are shaped in such a way that it facilitates arriving at the 'happy mean'.

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[3] Situation is defined as a nominal location of one place related to others.
Aspect is defined as the compass direction a slope faces.

[4] Walsh, Joseph M (1894). *Coffee: Its History, Classification and Description* . The John C.Winston Co.: Philadelphia. p.46.

[5] Hull, H.C.P (1877), *Coffee Planting in Southern India and Cylon*, E & F.N. Spon, Charing Cross: London. P. 42.

[6] Elliot, Robert. H (1871), *The Experiences of a Planter in the Jungles of Mysore,* Chapman and Hill, Piccadilly: London.

[7] Arnold, Edwin Lester (1881). *On the Indian Hills: Coffee Planting in Southern India*. Sampson Low, Marston, Searle and Rivington: London.

While exploring the contemporary understanding of what now constituted the 'happy mean' for coffee growers, I asked them to comment on what they now consider to be 'normal rainfall'. Prasanna M, a coffee grower, noted that he worked towards sustaining a 'band of manageable conditions'.[8] The concept of 'band of manageable conditions' was also best explained by M. Majunath, a so called 'progressive' Arabica grower in Ballupet near Sakleshpura, Karnataka. Manjunath has not been deterred by the fact that his estate is mostly located at lower elevations, which are not necessarily ideal for growing Arabica coffee. The secret of this success, according to him, lies in how he conceptualizes and sustains his 'band of manageable conditions', which involves nurturing mutually supporting elements: a pond & a well (a natural source of water), a herd of cows, thick canopy of forest cover and a second layer shade provided by dadap trees.

The cows, according to him, are important not because they provide milk for consumption but, more significantly, for the organic manure (cow dung) which is crucial for fertilizing the coffee crop. In other words, for the grower a series of elements need to be sustained as interlinked and interdependent variables for coffee growing.[9] The growers willingness to use the terms 'band of manageable weather conditions' or 'happy mean' instead of using the terms 'ideal' or 'normal' weather reflected their situated experience of weather.

Central to this approach of 'band of manageable conditions' is the fact that it recognizes that each estate is in several ways topographically and ecologically unique. The Western Ghats receives plentiful rainfall but the regional topography nonetheless also plays a crucial role in shaping the micro-climate within individual estates. The regional topography results in a high degree of variability in the total amount of rainfall received in an area. Therefore the idea of what constitutes 'normal' rainfall within the same rainfall regime and even within the same estate is also varied. Hence it was very

[8]Prasanna M, coffee grower, Magadi Mane Halasulige Post, Sakleshpura, Hassan district, Karnataka.Interviewed on 26/11/2011 for 1hour 30 minutes at his home.

[9]Manjunath, arabica coffee grower, Rudraprayag estate, Ballupet, Sakleshpura interviewed on 22/12/11 (30 minutes) at his home.

difficult for growers even with their rainfall records to define normal rainfall for their estates in terms of absolute precipitation. Shiv Shankar Belagola a grower near Badra forest in Chickmaglur district in Karnataka came closest, in my opinion, to defining a successful blossom shower in terms of the quantity of precipitation. According to him,

> *Revathi* (blossom shower) should not be less than 20 mm. but if the downpour was heavy it might result in the dropping of flowers before pollination. Significantly as well, if the grower followed a misleading prediction about the timing of the *Revathi* (blossom shower) by irrigating his crop as a mitigation strategy, then a late backing shower could also result in the flower dropping. Even delayed backing showers would not cause any harm if *Revathi* (blossom shower) brings up to 75-85 mm of rain. On the other hand 40 -60 mm of rain during *Revathi* (blossom shower) is not bad but it needs to be immediately followed by backing showers. Also the coffee flowers do not open properly in case there is an average rainfall (40-60 mm) during *Revathi* (blossom shower) which is then followed by delayed backing showers.[10]

In the above lines, the coffee grower is essentially sharing what a successful blossom shower means for him. As is evident, for a grower, there are different ways in which a blossom shower can afford a success. A very heavy or very weak blossom shower (less than 20 mm) is not useful. 40-60 mm of blossom shower is successful if it is followed immediately with backing showers. Whereas 75- 85 mm of rainfall gives growers time in case the backing showers are delayed. The success of the blossom shower is not decided by the absolute quantity of precipitation but rather the impacts of the latter are assessed on a range of natural elements critical for growing the coffee that precede or succeed the rainfall event. The natural elements that are alluded to by T. Krishnamurthy, a coffee grower in the Palini hills Tamil Nadu, tell us how he identifies the ‘failure of rainfall’ in his estate by describing what he calls as the ‘bubble effect’ in the coffee cherry.

[10]Shiv Shankar, coffee grower, Belagola Estate, Bogase Post, Chikmaglur Taluk, Chiklmaglur district, Karnataka. Interviewed on 11/12/11 for 50 minutes.

> Upon squeezing the fruit if there is a gap or air between the pulp and the outer skin of the fruit that means either the fruit has not developed properly or shriveled due to insufficient water availability.[11]

For him it was not the amount of rainfall received per se but if the bubble effect was or was not observed in the coffee fruit, which was indicative of drought conditions in his estate. While underperformance of rainfall can thus lead to this situation, it can also result from rains which come as a downpour and give little time for the soil to absorb the moisture. While rain-gauges, on the other hand, will report the actual amount of rainfall, these instruments will not be able to indicate the impact of the precipitation on the soil. This is specially a cause of concern in Palni hills region. In this region, in particular, since these estates are located on a steep slope, a heavy precipitation event might just as well amplify soil runoff rather than moisture retention.

Apart from the variation in coffee growers experience within the same rainfall regime there are significant differences in the fruiting and flowering patterns in the different rainfall regimes. For example, in the Palini hill estates which receive mainly the North-East monsoon and record maximum rainfall in the month of October, the coffee harvesting can be carried two to three times a year. Even though, it must be added, that the quantities of coffee harvested is often less in comparison to their counterparts who grow coffee in estates located in the South- West Monsoon belt. They usually aim to harvest a heavy crop only once a year. The Palini hill estates are located at higher altitudes and are climatically better suited for Arabica. Commenting on the importance of rainfalls for coffee estates Dr. Pradeep, ex-president Karnataka Growers Federation, mentioned:

> Like all fruit crops, coffee is a gamble on the weather. The rubber planter gets his crop in any case, tea may be held up by drought but has chance of

[11] T. Krishnamurthy, 7-3-8 D, Batlagundu Main road, Pattiveeranpatti-624211, Dindigul district, Tamil Nadu interviewed on 26/2/14 for over 3 hours.

> making up later in the season, but anything happens to coffee growers' blossom he is done for until another year comes around.[12]

Growers regularly monitor rainfall through a calibrated rain gauge usually placed in the drying yard in the estate. A drying yard refers to a flat cemented surface that is usually used for drying washed coffee.

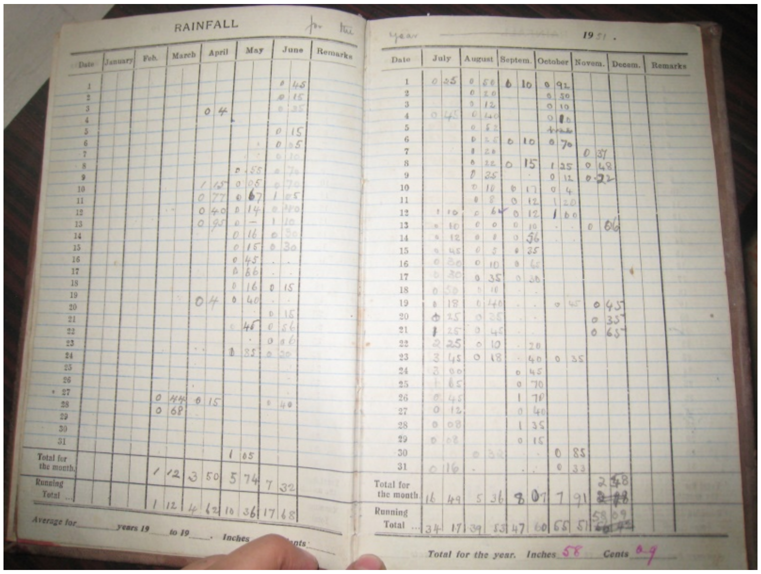
Picture 16: Shiv Shankar Belagola, Coffee grower in Chikmaglur, showing the method of measuring rainfall on the coffee estate.

The rainfall records thus maintained could go back several years and decades. This was evident through records which the growers happily made available to me. While records were systematically maintained they were not at the center of the growers' perception of the rainfall. It was evident from the fact that records came into conversations only when growers were specifically asked about them. To me, in fact, it was important to always note that the growers never seemed to refer to their records when sharing their rainfall concerns.[13]

[12] Dr. Pradeep N. K, Sri Nandi Estate, Sakleshpur. Interviewed on several occasions. This excerpt is from the conversation we had on 6/1/15 in Somwarpet, North Kodagu during a KGF gathering.

[13] See annexure 21 for sample rainfall data gathered from the coffee estates during field work.

Picture 17: Rainfall records at Tata coffee estate, Kottebetta, Kodagu.



Their rainfall records, in effect, to me perhaps strongly suggested that the growers' idea of normal rainfall and their perception of it needed to be situated in the unique topographical, ecological and, climatic contexts in which the estate was located. Their perceptions about rainfall, hence, appeared to emerge from their unique ecological contexts. While these growers thus do consider the significance of the quantity of rainfall, the impact of precipitation on the quality and quantity of the coffee crop is weighed against a range of ecological, topographical and climatic contexts .

RISC as the Insurers' perception

Given that the performance of rainfall is of prime concern to coffee growers, the Coffee Board introduced an insurance scheme to address these concerns. The scheme is known as the Rainfall Insurance Scheme for Coffee (RISC). The RISC was introduced in 2007-08 by the Agriculture Insurance Company of India (AICI or AIC) in consultation with the Coffee Board of India for coffee growers in the three traditional coffee growing South Indian states: Karnataka, Kerala and Tamil Nadu. RISC is now very much part of the socio-economic landscape on the ground.

The format used for designing RISC makes it particularly important for this study. The scheme indexes rainfall by identifying a 'normal' rainfall for a particular geographic location in terms of the absolute amount of precipitation over a period of time. This section unpacks the indexing exercise to understand how the scheme a) arrives at these precipitation numbers and b) assesses the impact of the rainfall in terms of absolute precipitation. The RISC provides cover for four types of rainfall in the coffee belt of the Western Ghats: blossom shower, backing shower, monsoon shower and post monsoon shower. The definitions of 'normal' for the insurers comprise the following:

Table 6: Rainfall definitions as mentioned in RISC document.

Rainfall	**Definition as per RISC Document available on Coffee Board Website.**[14]
Blossom Showers	shall mean the rainfall received between 1st March to 15th April (Robusta) and 1st March to 30th April (Arabica)for the bud to flower (bud enlargement and anthesis). The normal requirement of rainfall is 25 mm in five consecutive days for Arabica and 20mm in seven consecutive days for Robusta.
Backing Showers	shall mean the rainfall received from 18th day of the starting of blossom shower till 40th day to achieve full fruit development & retention. The normal requirement of rainfall is 12mm in two consecutive days.
Monsoon Showers	shall mean the rainfall received from 1st June to 30th September for the fruit to grow in size. The aggregate rainfall of beyond a specified limit in any seven consecutive days during the period is likely to adversely affect the coffee yield.
Post Monsoon Showers	shall mean the cumulative rainfall of atleast 100mm received continuously over a period of 5 days in case of Arabica during 1st November to 31st January . The cumulative rainfall of atleast 125mm received continuously over a period of 7 days in case of Robusta coffee during 1st December to 28th February

Each definition has three components: a) fixed time frame b) moving time frame c) amount of rainfall. For instance in case of the blossom showers for the Robusta fixed time frame, is listed as 1st March to 15th April. The moving time frame is seven

[14] Rainfall Insurance Scheme –Coffee (2011-12), http://www1.indiacoffee.org/userfiles/RISC%202011%20Karnataka1.pdf(23rd June 2012).

consecutive days during the fixed period and the minimum amount of rainfall is 25 mm. The amount of rainfall is further divided into slabs which decide the amount of payoff to be given. These slabs, moreover, are based on the geographic location of the place where the estate is located. For example, the following is a trigger[15] and the payout slab table for the blossom rainfall cover for Arabica in the Karnataka State, Chikmaglur district, Aldur zone for the year 2015.

Picture 18: Blossom cover in RISC for Arabica coffee in Aldur zone Chikmaglur district, 2015.

AIC Of INDIA LTD

RAINFALL INSURANCE SCHEME FOR COFFEE (RISC) 2015

State : Karnataka **District: Chikmagalur** **Zone Aldur** **Sub Zone: Aldur**

Variety : Arabica **Unit : Hectare**

Cover :1 Blossom Rainfall

Period : 01-Mar To 30-Apr

Condition : The payout will start if the cumulative rainfall is less than 25 mm in 5 consecutive days during the specified period
In case of multiple events and all are of less than 25 mm (over 5 consecutive days), the event with maximum rainfall would be considered.

Trigger and payout slab ::

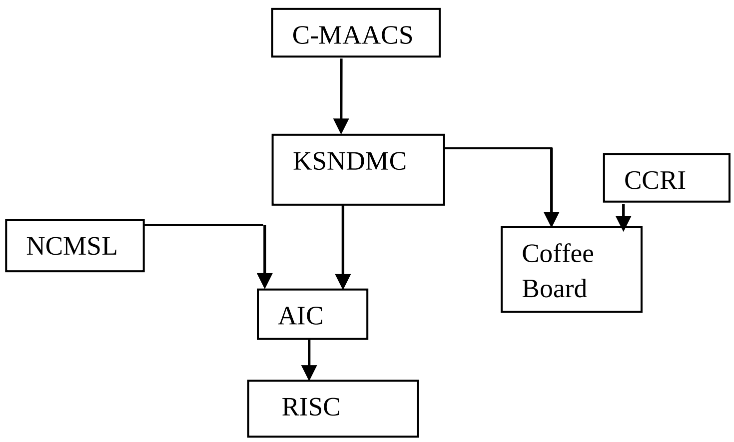
RF <(In mm)	Payout (In Rs)
25	2500
20	3500
15	5500
10	7500
5	10000

A network of various meteorological organizations involved in measuring rainfall help in identifying the triggers for RISC. The Agriculture Insurance Company (AIC), for example, uses past rainfall records and yield data to statistically arrive at a proposed set of trigger levels. These proposed triggers are then shared with the Coffee Board. The Coffee Board in turn consults Karnataka State Disaster Management Cell (KSNDMC) to confirm the rainfall data and check the probability of the occurrence of the proposed trigger levels. Simultaneously, Coffee Board consults Central Coffee Research Institute (CCRI) to assess different water stress levels for coffee plants under the proposed triggers. To confirm the probability of the prosed triggers, the KSNDMC consults the Centre for Mathematical Modeling and Computer Simulation (C-MAACS). Below is the

[15] Trigger refers to the amount of rainfall which if recorded at the respective RRG will initiate the payouts.

diagrammatic representation of the institutional network of meteorological organizations which work together to identify normal rainfall and triggers for RISC.

Figure 2: Network of meteorological organizations informing RISC.



Unpacking the indexing process of rainfall for RISC highlights that insurers identify normal rainfall based on the correlation between previous rainfall and the coffee crop yield output data. While rainfall data is obtained from the KSNDMC, C-MMACS, NCMSL and the Indian Meteorological Department (IMD), the coffee crop output yield data is obtained from the Coffee Board and CCRI. For insurers, normal rainfall is strongly related to coffee productivity. The amount of rainfall which is sufficient to release the stress of the plant and initiate blossoming is thus considered to be normal rainfall. Similarly, the amount of rainfall which causes physiological stress in the plant by being insufficient or in excess is abnormal rainfall. Coffee output and rainfall thus establishes this correlation.

‘Normal’ rainfall for the meteorologists

For meteorologists a normal rainfall is defined as the arithmetic average of a climate element (e.g. temperature, rainfall) over a 30-year period. A 30 year period is used, as it is long enough to filter out any inter-annual variation or anomalies, but also short enough to be able to show longer climatic trends.[16] The current climate normal period is calculated from 1 January 1961 to 31 December 1990.[17]

The method to delineate the normal dates for the occurrence of a weather event such as monsoon rainfall is based on statistical analysis. Each month is divided into five day periods or pentads as they are generally referred to. Using statistical tools, the normal rainfall for each pentad is calculated from the climatological records. It is possible to do this for all parts of the country over which a fairly dense network of rain gauges have been in existence for over seventy-five years. Around the time of arrival of the monsoon, the normal rainfall over a particular pentad exhibits sudden and well-marked rise over its two or three preceding pentads. The normal date of the monsoon is the pentad which exhibits a sudden increase in rainfall.

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[16] Role of 'normals' in connecting the Meteorology, climatology and climate science network in India is as follows:
Indian Meteorological Department is responsible for collecting everyday data from the various data collection units across the country and use weather forecast models to share forecasts. The data collected every-day is stored and eventually sent to climatology division at IMD headquarters in Pune, Maharashtra. The climatology division here uses statistical tools and work on this data to arrive at the normal value for rainfall for different regions of the country. As mentioned in main text, time is an important component in deciding normalcy. At present the time period is prescribed by World Meteorology Organization (WMO) is 1 January 1961 – 1 January 1991. The normals so generated are then used by weather scientists to assess the performance of particular weather event. Climate scientists at Indian Institute of Tropical Meteorology (IITM) use it to arrive at the boundary condition for running their models. Boundary conditions in climate modeling are like initial conditions for weather forecasting. A minor change can lead to unpredictable change in the projections thus increasing the uncertainty.
Source: based on the information gathered during field work.

[17] World Meteorological Organization, *Climate Data and data related products*http://www.wmo.int/pages/themes/climate/climate_data_and_products.php (15/7/2015).

Table 7: Pentad formation. Each pentad is highlighted by an individual color.

1	Day 1										
2	Day 2	Day 1									
3	Day 3	Day 2	Day 1								
4	Day 4	Day 3	Day 2	Day 1							
5	Day 5	Day 4	Day 3	Day 2	Day 1						
6		Day 5	Day 4	Day 3	Day 2	Day 1					
7			Day 5	Day 4	Day 3	Day 2	Day 1				
8				Day 5	Day 4	Day 3	Day 2	Day 1			
9					Day 5	Day 4	Day 3	Day 2	Day 1		
10						Day 5	Day 4	Day 3	Day 2	Day 1	
11							Day 5	Day 4	Day 3	Day 2	Day 1
12								Day 5	Day 4	Day 3	Day 2
13									Day 5	Day 4	Day 3
14										Day 5	Day 4
15											Day 5

What is critical to understand in the pentad construction is that day 1,2,3 refers to the temporal distribution of time. This distribution pattern sets the temporal boundaries for the weather event. An example of the working rules for the onset of monsoon is as follows: beginning with 10 May if at least five out of ten meteorological stations in Kerala report twenty-four hour rainfall amounts of 1 mm or more for two consecutive days, the monsoon's onset is declared on the second day.

Over the course of the several interviews conducted with meteorologists at the Indian Meteorological Department (IMD) office in Delhi, Pune, Bangalore; climatologists at National Centre for medium Range Weather Forecasting (NCMRWF) Noida and climate scientists at Indian Institute of Tropical Meteorology (IITM) Pune and Indian Institute of Technology (IIT) –Delhi, what stood out for me was that the pursuit of the idea of what constituted 'normal rainfall' conditions threaded concerns about climate science, climatology and meteorology.

For climate the 'normal' is often used for assessing the performance of recurring weather events and serve as key components in defining boundary conditions[18] for climate modeling.[19] The Normal is the baseline against which variation in reported in everyday weather reports. It is also the baseline against which the future climate is projected. For meteorologists 'normal' is a function of spatial and temporal boundaries. If these boundaries were to change so would the value of the normal. Meteorologists, therefore, perceive rainfall in terms of quantitative measure of precipitations assessed through data gathered during a specified period of time.

Experienced rainfall vs indexed rainfall: unprecedented variations

This section explores these different perceptions of rainfall in the context of variations in rainfall that are experienced by coffee growers on the ground. The section identifies monsoon, dry spell and pest and disease cycle as the points of comparison. While experienced rainfall refers to growers' situated perception of rainfall indexed rainfall refers to the statistical assessment of rainfall in absolute numbers by RISC.

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[18] Boundary conditions are weather parameters which are fixed while studying climate simulations. Inputs for the fixed boundary conditions are obtained from observed weather data sets.

[19] Interview with Dr. Raghavendra Ashrit, Scientist, National Centre for Medium Range Weather Forecasting (NCMRWF), interviewed on 24/11/2014. Total Duration: 1 hour 30 minutes.

Temperature trends

The ideal temperature for growing Arabica is between15^0- 26^{0}C. The plant overall, however, prefers a relatively cool climate. Robusta, on the other hand, does reasonably well even at relatively higher temperatures. The ideal temperature for Robusta is 20^0- 30^{0}C and prefers humid conditions as well. In South India, the sometimes high summer temperatures combined with poor sub-soil moisture can become severe limiting factors for the total coffee crop output. Dr. Anand Periera, a grower from Sakleshpur region, known for his extensive investments in artificial irrigation systems, in his estimate felt that there was a visible rise in overall temperature through the years. According to him, if 20 years ago the temperature touched 32^{0}C it meant that they would have a downpour. But in 2010, even if the temperature touched sometimes as high 33^{0}C the rains did not necessarily follow. Commenting on these temperature trends, Mr. Bassana, a senior coffee grower in Anemahal, Sakleshpur, shared an anecdotal observation:

> In summers, during my childhood, if we were to sweat while sitting inside our house it was sure sign of approaching rains. Now there is no correlation. Summers are definitely much hotter now.

Another senior coffee grower Gangehegde further supported this observation:

> Growers regret not maintaining temperature records. While we can feel it, it is difficult to provide data.

To support his observations he has started maintaining temperature records at his estate.

Picture 19: Thermometer installed at the porch to measure temperature.

In a coffee estate, temperature trends are directly related to vegetative growth and more specifically with the growth of leaves. Leaf growth shows periodicity with maximum number of leaves initiated in August/September. The leaves that grow during this period tend to be larger and are found to be associated with the maximum temperature range of 23^0 C -27^0 C and minimum temperature range of 11^0 C to 12^0C.

However, a high temperature inhibits leaf expansion and causes formation of smaller leaves. Smaller leaves pose limit to the ability of the plant to grow and manufacture food for itself. Irrespective of the performance of rainfall, the higher temperatures in fact limits the net crop output. While such observations are reflected in the growers' situated experience of weather on the coffee estates it is not always captured in the indexed understanding of rainfall which informs RISC.

Monsoons

In the Western Ghats belt the South-West monsoon sets in during the month of July and lasts till the later part of August and early September. In October, one witnesses the play of the North-East monsoon. However, several growers whom I spoke with argue that in recent year they have increasingly begun to perceive a kind of 'lateral shift in the behavior of the Monsoon'. In the words of Dr. Anand Periera :

> the beauty of the monsoon pattern in the shade growing coffee regions is its distribution. In coffee, the quantum of rainfall is not important rather the distribution pattern over the period of five months is crucial. Instead of being distributed over five months, the major chunk of monsoonal rainfall in now concentrated within two months. This kind of downpour leads to soil erosion, making coffee plants more fragile and thus introducing new kinds of pests and diseases.[20]

The accumulation of the monsoonal rainfall into a two month period has created new problems on the ground. Instead of being uniformly distributed, the monsoon now arrives as a downpour and soil do not get time to absorb and retain moisture. There are, in fact, increased chances of soil erosion and the spread of black rot disease increases — a fungal infection that affects leaves, developing berries and tender shoots. Favorable conditions for this disease include continuous and heavy monsoon without a break or dry period.

This change in the pattern of distribution is not reflected in the calibrated monitoring of monsoon by the meteorologists, who focus only on the overall cumulative amount of precipitation. While the lateral shift in the monsoon has had visible impacts on the ground, cumulatively speaking, however, the monsoons do not show a sharp behavioral change. The meteorological exercise of calibrating and indexing the monsoon would arguably thus report a normal monsoon or an approximate thereof. However its

[20] Dr. Pereira, coffee grower, Joe's Sustainable Farm , Kirehully Estate, Sundekere Post, SakleshpuraTaluk, Hassan District, Karnataka. Interviewed on 29/11/11 (over 3 hours) and 21-02-14 (2 Hours).

uneven distribution leaves the grower unsatisfied both during early phase of the monsoon and during the later one.

Monsoon breaks

One of the most discussed aspect of the accumulation of monsoonal rainfall in a two month period by the growers is often the absence of the monsoon break. Traditionally after onset of the monsoon, for the growers there are one or two breaks in between which can last from a couple of days to over a week. These breaks are important because they believe it gives the coffee plant a) respite from the continuous showers, b) gives chance for the soil to absorb the water and c) prepares the plant for the next round of monsoonal rainfalls.

However, with the concentration of monsoons in the two month period, the growers now feel that the monsoonal breaks can no longer be observed. So while the amount of rainfall received has not increased or drastically decreased, the absence of monsoonal break renders the plant incapable of processing the rainfall water efficiently. RISC in the monsoonal cover provides caps for cumulative rainfall received over any 7 consecutive days during the monsoon months. In the changing scenario what this index rainfall risk is unable to factor in, according to the growers is the role and importance of the monsoonal breaks.

Dry Spell

The dry spell is a period of ninety days that are observed from the end of monsoons till the commencement of the blossom shower in the next year. More specifically, it refers to the months of November, December and January. Girish, a coffee grower whose coffee estate is located near Sakleshpur in Hassan district, Karnataka, discussed the importance of this dry period. According to him:

> this causes water stress in plants which show uniform blossoming upon being exposed to first rainfall (blossom showers) in the months of March and April.[21]

The dry period according to him is thus important in order to generate the maximum impact of the rainfalls. Geetha Suresh, another grower from the same region, similarly flagged for me the importance of the dry period in determining the success of the following rainfall. She pointed towards untimely blossoms in her estate:

> Early December is the period when the soil had been recently manured and this is half way into the period of the dry spell. Thus even a sprinkle would initiate blossoming. But this untimely blossoming will wither away. This untimely blossom in turn dilutes the impact of the *Revathi* (blossom shower, first rainfall of the season that initiates blossoming). And by the time the full force of the *Revathi* comes these buds would already be lost and hence there would be a net loss even if *Revathi* delivers as per expectation.[22]

In such cases even if the insured blossom showers did perform as per expectation, the grower would already have lost part of the crop. The indexed rainfall risk is not designed to address the factors preceding the rainfall or succeeding the rainfall.

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[21]Girish, coffee grower, Hassan District Planters Association office interviewed on 22/11/11 (2hrs) and 19/2/14 (1 hr. 30 minutes).

[22]Geetha Suresh, coffee grower, Jaladarshini estate, Bykere Post, SakeleshpuraTaluk, Hassan district, Karnataka. Interviewed on 5/12/11 (over 2 hrs).

Picture 20: Untimely blossoms seen at Geetha Suresh's coffee estate in Sakleshpur, Hassan Karnataka

Changes in crop cycle

During the interviews carried out in the Karnataka region (South-West monsoon belt) in 2011, the rainfall in November and December were considered as an abnormality but during the second round of field work in 2014 coffee growers kept calling this abnormality as the new normal. Growers appeared worried about the implications of this new normal. For growers in South- West monsoon belt this meant harvesting small crops 2-3 times a year instead of harvesting a big crop once a year as they have been doing traditionally.

Picture 22: Workers sorting their day's coffee harvest.

Temperature, Rainfall and White Stem Borer

In a coffee estate rainfall is the trigger that kick starts the crop cycle. However the impact of rainfall is dependent on the temperatures being experienced. The most intricate relation of the two is observed in fighting pests like White Stem Borer (WSB). Exposure to high temperatures for a prolonged period results in high pest incidences like WSB.[23] Estates in South –West monsoon belt especially the once located in Hassan district in Karnataka State have been witnessing widespread infiltration by White Stem Borer (WSB) in Arabica plants.

Coffee White Stem Borer, *Xylotrechus quadripes*, is a serious pest for the Arabica coffee causing a yield loss up to 40 per cent in all coffee growing areas of India.[24]The worst infestation of White Stem Borer in South- West Monsoon belt was experienced during the drought of 2002-2005. It is widely recalled that during drought conditions, or even due to a sharp lack of rainfall, infestation incidences increase. But unlike previous drought incidences, Arabica has not been able to recover in this region since then.

[23] Pereira, Anand.T. &Geeta.N.Pereira (2009).*Ecofriendly Coffee*.Volume1: p.548.
[24]J.Jayaraj and N. Muthukrishnan (22/5/2013), Management of White Stem borer in Coffee, *The Hindu*.

According to H.R. Bassana 'temperatures are relatively higher. WSB stays dormant during the rainy season but appear again once the rainfall stops.'[25]

Picture 22: Coffee grower showing hollow stem of a coffee plant infested by White Stem Borer

To curb the WSB menace the Coffee Board introduced monetary incentives to growers for tracing[26] White Stem Borer in all its forms (pupae, larvae and adult beetle).[27] In order to break this cycle of infestation, the growers are increasingly switching to Robusta. In the time of changing weather patterns, the idea of drought (conventional failure of rainfall) is increasingly being associated not just with failure of one or two crop output cycles but with the losses arising plant infestation. More importantly, as is evident now, risk assessment of drought for a grower also includes the investments in reorienting or shifting the coffee estate from growing Arabica to Robusta. RISC identifies the rainfall

[25] H.R. Bassana, Anne Mahal village & Post, Sakleshpura Taluq, Hassan, Karnataka. Interviewed on 21/11/11 (one hour).

[26] Tracing WSB is done throughout the year relying on the ridges on the coffee plant as identification marks. The infested plants also show symptoms of yellowing and wilting during periods of moisture stress. The borer affected plants, during this period, show wilting symptoms, especially the drooping of the first pair of leaves on the branches. This generally happens after cessation of monsoon. Such plants need to be uprooted immediately and destroyed by burning.

[27] Pereira, Anand.T. &Geeta.N.Pereira (2009).*Ecofriendly Coffee*.Volume1: p.548.

failure but in the changing conditions the extent of experienced damage because of increased temperatures is not accounted for in the indexed rainfall.

Honeybees and pollination

Robusta which is planted because of its higher resistance to WSB faces another set of problems. It is a cross pollinated plant and the honey bee is crucial for the pollination of the Robusta plants. The Robusta growers, in fact, in my interviews, very fondly remembered 'how till a few years back, during flowering season one could hear the hum of honey bee from a long distance'.[28] Now honey bees are scarce. Though no scientific studies are yet available for their diminishing numbers, Kannan, a coffee grower and a bee keeper attributes their absence to the rising high temperatures. The absence of honey bees result in a reduced degree of pollination. As a result, it is feared that the fruit setting or ripening will be affected and there could potentially be reduction in net crop produced.[29]

Picture 23: Curbing the spread of WSB in the coffee estate by uprooting the infested plants.

[28]Girish, coffee grower, Hassan District Planters Association office interviewed 19/2/14 (1 hr. 30 minutes).

[29]Kanan, coffee grower and bee keeper, 7-3-8 D, Batlagundu Main road, Pattiveeranpatti-624211, Dindiguldistrict, Tamil Nadu interviewed on 26/2/14 for over 3 hours.

Hedging returns and local ecology

With this increasing shift towards Robusta, the understanding of weather variation and vulnerability amongst coffee growers is becoming even more puzzling.[30] Robusta can grow fairly well amidst sparse shade conditions and Robusta growers can then quickly replace the relatively thick tree cover (vital for Arabica) with the distantly spaced fast growing silver oak (*Grevillia robusta).* In effect, the growers, whom I had interviewed, seemed to suggest that their shift towards Robusta was a way of responding to or hedging their production calculations in the context of a perceived sense that coffee production increasingly had to deal with vulnerability from weather variation.

Many of them, in fact, seemed convinced that changing rainfall patterns in the region were causing delays in the blossom showers and rising temperatures were also beginning to take effect. A rise in temperature, as argued in the previous section, moreover, also created favorable conditions for enabling White Stem Borer infestations. In sum, the shift to Robusta was meant to be a response to increasing weather vulnerability. In comparison to Arabica, the Robusta requires little shade. With reduced requirement for shade a once thick cover of mixed trees is now being chopped and replaced with fast growing tree varieties like Silver Oak which are treated as standing timber crop. Additionally, cultivation practices carried out for maintaining shade cover like shade lopping require skilled labour. Silver oak requires very little maintenance. Removing shade cover saves this cost for growers. Earlier, the importance of this shade cover was held to be almost self-evident.

Traditionally, a typical coffee estate in the region that was growing Arabica would have a shade cover of about 150 to 200 trees per hectare. This tree cover was not merely a question of shade but also seen as being critical in checking pest populations (such as White Stem borer) and therefore keeping the coffee safe from pest attack. In particular, the shade cover kept the plants healthy by maintaining the latter’s evergreen

[30] To see data on this trend please refer to annexure 14.

leaf color and helped the coffee achieve a uniform fruit setting. In his encyclopedia on Shade grown coffee, Dr. Pereira writes

> In coffee blocks thickly populated with indigenous tree species like *Erythrina*, *Cedrus* (red &white cedar), *Syzygium cumini* (Jamun), *Ficus sp*., *Artocarpus heterophyllus*(Jackfruit) etc. the coffee plants appear very healthy, the leaf colour green, big in size, good and uniform fruit set and mature beans with negligible pest and disease incidences. On the contrary in coffee blocks having locally introduced fast growing tree species like *Grevillia robusta* (Silver Oak), *Mesopsis sp*., *Eucalyptus sp.*, *Acacia sp.*etc. the plants lack vigor and are more prone to pest and disease incidences.[31]

The trees, it was authoritatively held, were responsible for not only bringing rain in time but also apparently critical to sustaining the flow regimes of the six rivers that originated from the Western Ghats. Thus, shade for coffee was meant to be a de-facto weather regulator and therefore critical to maintaining faunal diversity, enriching the soil and moderating the complex microclimate of the area.[32] Such coping strategies for sustaining revenue in the face of more pronounced climate change impacts, in turn, have adverse consequences for the environment.[33,34,35,36,37,38,39,40,41,42] Therefore, in the face of

[31]Pereira, A.T., & Pereira, G.N. (2009).*Ecofriendly Shade Grown Coffee* Volume1:p.299.

[32] To see list of native trees found in the coffee growing belt of Western Ghats refer to annexure 7.

[33]S.Ambinakudige & B.N. Sathish.(2009). Comparing tree diversity and composition in coffee farms and sacred forests in the Western Ghats of India. *Biodiversity Conservation* 18:987–1000.

[34] B.N.Sathish. (2005) Assessment of tree diversity in coffee plantations under different land tenure systems in Virajpet Taluk, Kodagu. College of Forestry, University of Agricultural Sciences, Ponnampet, Bangalore.

[35] A.S.Shrinidhi & S. Lele . (2001). Forest tenure regimes in the Western Ghats: a compendium. Bangalore. *Institute for Social Economic Change* 90:56.

[36] Utkarsh G et al (1998) On the patterns of tree diversity in the Western Ghats of India. CurrSci 75:594–603.

unprecedented variation in weather, the failure of rainfall is not an independent event any more. Substantiated by other impacts a drought is thus merely a trigger for a setting of a cascade of negative environmental feedbacks.

Concluding remarks and discussion

The chapter began by discussing by three different perceptions of rainfall in the coffee growing districts located in the Western Ghats belt of South India. These perceptions are, I point out, of coffee growers, insurers and meteorologists. The chapter unpacks the idea of 'normal rainfall' and argues that the growers' perception and understanding emerge from the unique topographical, ecological and, climatic context in which their estates are located.

For insurers, on the other hand, normal rainfall is a function of the statistical pattern that emerges from the data sets on rainfall and crop yield. The amount of rainfall which is sufficient to release the stress of plant and initiate blossoming is considered by the insurers to be normal rainfall. Similarly, the amount of rainfall which causes

[37] Pascal JP, Ramesh BR (1987). A field key to the trees and lianas of the evergreen forests of the Western Ghats (India).InstitutFranc¸ais de Pondiche´ry, Pondicherry.

[38] Neilson J (2008) Environmental governance in the coffee forests of Kodagu, South India. *Transforming Cultures eJournal* 3(1):185–195

[39] Nath CD, Dattaraja HS, Suresh HS et al (2006) Patterns of tree growth in relation to environmental variability in the tropical dry deciduous forest at Mudumalai, southern India. *Journal of Bioscience* 31:651–669.

[40] Elouard C, Chaumette M, de Pommery H (2000) The role of coffee plantations in biodiversity conservation. in: *Mountain biodiversity, land use dynamics, and traditional ecological knowledge.* Ramakrishnan PS, Chandrashekara UM, Elouard C et al (eds) Oxford and IBH, New Delhi, pp 120–144.

[41] Garcia CA, Bhagwat SA, Ghazoul J et al (2010) Biodiversity conservation in agricultural landscapes: challenges and opportunities of coffee agroforestry in the Western Ghats, India. ConservBiol 24:479–488.

[42] S. Ambinakudige.(2006). Differential impacts of commodification of agriculture in the Western Ghats of India: an extended environmental entitlement analysis. Florida State University, Tallahassee

physiological stress in the plant by being insufficient or in excess is considered to be abnormal rainfall.

For meteorologists, the 'normal' is a function of temporal boundaries within which the precipitation event can be monitored. If these boundaries were to change so would the value of the normal. Normal is the baseline against which variation in reported in everyday weather reports. It is also the baseline against which future climate is projected.

The chapter then moves on to discuss how the growers sense of the normal is often strikingly different from that of the meteorologists and the insurers perception of normal rainfall. In sum, through interviews and observation on the field, I argue that the meanings of rainfall and its differing perceptions by coffee growers, meteorologists and insurers do not always converge on the ground. Deciding thus what comprises the real impacts of monsoonal rainfall and weather events for coffee growing remain contested and contentious on the ground.

Chapter 5

Irrigation and Insurance:
Decision-making and its dilemmas on the field

In chapter 4, I elaborated upon the three distinct perceptions about rainfall that could be discerned at the everyday level for coffee growing in South India: a) the growers' situated perception; b) meteorologists' perception informed by models, data and temporal boundaries and c) the insurer's perception informed by statistical assessment. This chapter will discuss how these distinct perceptions impact the decision-making abilities and choices of the coffee growers. In particular, I discuss two strategies that are available to growers for addressing their concerns when dealing with rainfall variation. The two strategies are: a) artificial or non-rain fed irrigation and b) insurance. While decision making for artificial irrigation requires credible rainfall forecasts, insurance, on the other hand, is based upon statistical patterns about rainfall, which is generated by data from a network of rain gauges.

Coffee growers experience a considerable degree of vulnerability and uncertainty before the blossom showers in their estates. Blossom shower, the first rain of the coffee crop cycle is crucial because it initiates the critical process of the maturing of the coffee berry. The arrival of this spell of rain at the right time and in a desired quantity along with the right temperature is crucial for ensuring that the remaining stages for the maturing of the berry coincides with the appropriate timing for the harvest.

Artificial irrigation, in fact, is a relatively new concept in the coffee estates, with sprinkler technologies being used only since the 1970s. [1] Initially it was introduced to support coffee plants in the summer period and was considered as an option to support up to a week of a possible delayed blossom and backing showers. Sprinkler irrigation, however, posed a set of limitations which we will discuss in detail in a later section in

[1] In overhead irrigation, water is piped to one or more central locations within the fields and distributed by overhead high pressure sprinklers or guns.

this chapter. To address the limitations of the sprinkler system a new technology called the rain-gun, in fact, was introduced in 2002.[2] The rain-gun unlike the sprinkler system is not modest in ambition as it is expected to replace in great measure the growers' dependence on natural rainfall.

Around the same time as the rain-guns were beginning to become somewhat popular in the estates, an insurance scheme called RISC was also introduced in the region. RISC is an Index Based Weather Insurance (IBWI) Scheme that aims to help growers' hedge and financially protect themselves from sharp rainfall variations. Both these strategies (artificial irrigation and RISC/insurance), however, have one thing in common, which is that they require credible meteorological assessments about rainfall patterns in the region and reasonably accurate precipitation forecasts. In effect, it is even possible to see a striking correlation between how both artificial irrigation and RISC require detailed inputs generated by meteorological stations and data sets provided by rain gauge networks.

This chapter will however point out that despite investing in these strategies ─, artificially reducing dependence on natural rainfall and insurance against financial loss ─ the growers continue to be vulnerable. In particular, as I will argue, over how the decision-making abilities for coffee growing can sometimes get undermined because of the differing perceptions over the meaning of rainfall.

Artificial Irrigation and Insurance

A 1974 article in the *Indian Coffee Magazine* about the use of artificial irrigation in Indian coffee estates is instructive. The article starts by stating that coffee yields tend to increase through the use of artificial or sprinkler irrigation and that the latter

[2] Rain-gun is a type of overhead irrigation. It irrigates estates in short period of time. These guns are light weight, fitted with turbines and gearboxes. The Italian rain-guns *Skipper* and *Mariner* were arguably first introduced in Joe's Sustainable farm in Sakleshpur in year 2002.In the year 2007 the same farm introduced another variation of rain gun known as *Gemini*.

technology thus is an insurance against crop losses.[3] This article was written much before the RISC was introduced for coffee growers.[4] The attempt to promote irrigation as an insurance against the failure of the coffee crop was carried out in a very different time from today when together with an insurance scheme the Coffee Board also provides subsidy to small growers for installing irrigation systems. But how does irrigation insure against the failure of the coffee crop? If artificial irrigation indeed has the potential of insuring against this crop loss then why was there a need, several decades later, for the government to introduce an insurance scheme alongside earlier efforts to promote artificial irrigation?

According to Dr. Chandra Gupt Anand, Divisional Head, Plant Physiology, Central Coffee Research Institute (CCRI), the effects of a delayed or inadequate blossom shower on the coffee plants urge us to consider the following:

> Coffee is a perennial plant with an annual bearing habit. The flower buds having been initiated by about August- September grow rather slowly and attain a size of 7 -8 mm by February and stop growing further. Rain or overhead irrigation [sprinkler] at this stage induces anthesis[5] of buds which open usually within 8-10 days. Successful blossom will be obtained with about 13mm of rainfall for Robusta and 25.4 mm for Arabica, depending upon overhead shade. Prolonged drought and inadequate showers provoke retardation of growth and production of star and snake mouthed flowers.[6]

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[3] S.R. Gopalan (1974), A Review of Irrigation in Coffee, *Indian Coffee,* p.46.

[4] Rainfall Insurance Scheme for Coffee Growers (RISC) was introduced in the year 2007-2008.

[5] Anthesis refers to flowering period of a plant, from the opening of the flower bud.

[6] Dr. Chandra Gupt Anand, Divisional Head, Plant Physiology, Central Coffee Research Institute (CCRI), Interviewed on 12/2/15, 5.00pm at his office in CCRI Balehonnur.

Picture 24: Deformed star mouthed coffee flowers. The deformation is a result of inadequate blossom shower. These deformed flowers do not pollinate and hence result in loss of crop.

Source: Central Coffee Research Institute

Picture 25: Deformed snake mouthed coffee flowers. The deformation is a result of inadequate blossom shower. These deformed flowers do not pollinate and hence result in loss of crop.

Source: Central Coffee Research Institute

In case of the inadequate or delayed blossom showers the sprinkler irrigation, we can see, does indeed supplements natural showers and can help avoid crop losses by way of pinking, paddying and the drying up of the buds.[7] Prolonged dry period after blossom shower, however, does result in the poor development of the berries and thus a poor harvest will in all likelihood follow. It is here that the sprinkler irrigation serves to check the vagaries of inadequate or delayed blossom showers/ backing showers thus serving as an insurance against net crop loss.

RISC, however, addresses the problem from a different perspective. Amongst the various options available for the RISC is that it insures against the failure of the blossom and backing showers. For example the condition for the blossom cover payout in Aldur Zone, Chikmaglur district in Karnataka for the year 2014 states that the payout will commence if the cumulative rainfall is less than 25mm in 5 consecutive days during the specified period.

Table 8: Blossom cover payout for Arabica in Aldur Zone, Chikmaglur district in Karnataka for the year 2014.

RF< (In mm)	Payout (in Rs) (per hectare)
25	2500
20	3500
15	5500
10	7500
5	10000

Source: Rainfall Insurance Scheme for Coffee (RISC) 2015. Available on Coffee Board website: http://www.indiacoffee.org/ (22/1/2017)

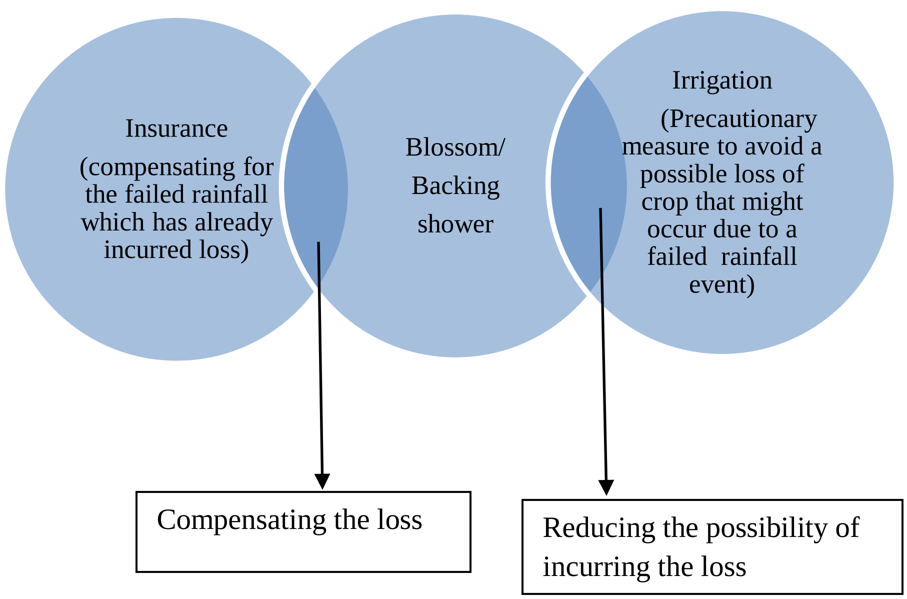
So in case of an insufficient blossom shower, the sprinkler irrigation compensates by providing the amount of water not received through rainfall whereas RISC

[7] Pinking and paddying are abnormal floral conditions which occur when the coffee plant is under stress. Stress conditions occur due to low humidity after flowering, prolonged high temperature and low rainfall.

compensates by triggering off the respective payout. Put differently, insurance is about financially compensating the loss that has already been incurred but in the case of artificial irrigation, the growers are trying to avoid the loss that they could potentially suffer.

The role of artificial irrigation as an insuring mechanism was thought about much later after its introduction in the 1970s. Initially irrigation was installed, as I mention earlier, to reduce the moisture stress in plants between the months of January and May. This dry period also coincides with the 'heavy crop load' ─ formation of flower buds, flowering and the emergence of the berry set. Any water stress when the plants are carrying the heavy crop also adversely affects the vegetative growth, which forms the next year's cropping wood[8] in coffee.[9]

Figure 3: Diagrammatic representation of insurers and growers (aided by their ability to irrigate) perspective of rainfall in the coffee estates.



[8] Cropping wood refers to the fruit bearing branches of the coffee plant.

[9] Y. Raghuramulu, N.Hariyappa and A.N. Manjunath (1996). Irrigation Management in Coffee. *Proceeding of National Seminar on Drought Management in Plantation Crops* (ed. Satheeeesan K.V.), Centre for Water Resources development and management (CWRDM), Kozikode, India pp.24-29.

Sprinkler irrigation and the challenge of labor

Introducing artificial irrigation through sprinklers within an estate ─ instead of waiting for the blossom showers to initiate the blossoming of the coffee berry ─ is not as simple a decision as switching on a power button. Running an irrigation system, in fact, requires the grower to carefully assemble an entire logistic involving: a) tapping into a perennial water source; b) connecting infrastructure which includes sprinklers, pipes, motor and running expenditure for fuel c) ensuring the timely availability of labor and d) keeping abreast with regular weather information in order to ensure that the artificial irrigation is not immediately followed by rainfall.

In this section, I discuss these various logistic dilemmas that follow with the introduction of the sprinkler irrigation system in the coffee estates. An effective sprinkler irrigation system consists of a diesel engine or electric motor that is coupled with G.I. pipes[10] and quick coupling pipes made of mild steel or aluminum. The G. I pipes or the cast iron pipes are used as permanent fixtures that serve as the main line when the water source is perennial and drawn from a single source.

Picture 26: Picture shows G.I. pipes laid down as permanent structure for irrigation. Kelagur Coffee and Tea Estate, Javali, Chikmaglur, Karnataka. 2/12/11.

[10] G.I pipes refers to galvanized iron pipes.

For ensuring the widest and precise watering of the different plots within the estate, an agile labor force has to be constantly rotating the irrigation pipes. This process is very crucial in getting the water to be uniformly spread to all the plants. The installation of this infrastructure and following it with high maneuverability needless to add incurs a heavy cost for the grower.

Picture 27: Picture shows quick coupling pipes laid out for irrigating a part of the estate. These are not permanent structures. Central Coffee Research Institute, Balehonnur, Chikmaglur, 5/3/14.

Apart from the one time investment in the physical infrastructure for the sprinkler system, there are also a range of recurring costs:

a) The costs are directly related to distance between the water source and the plots to be irrigated.

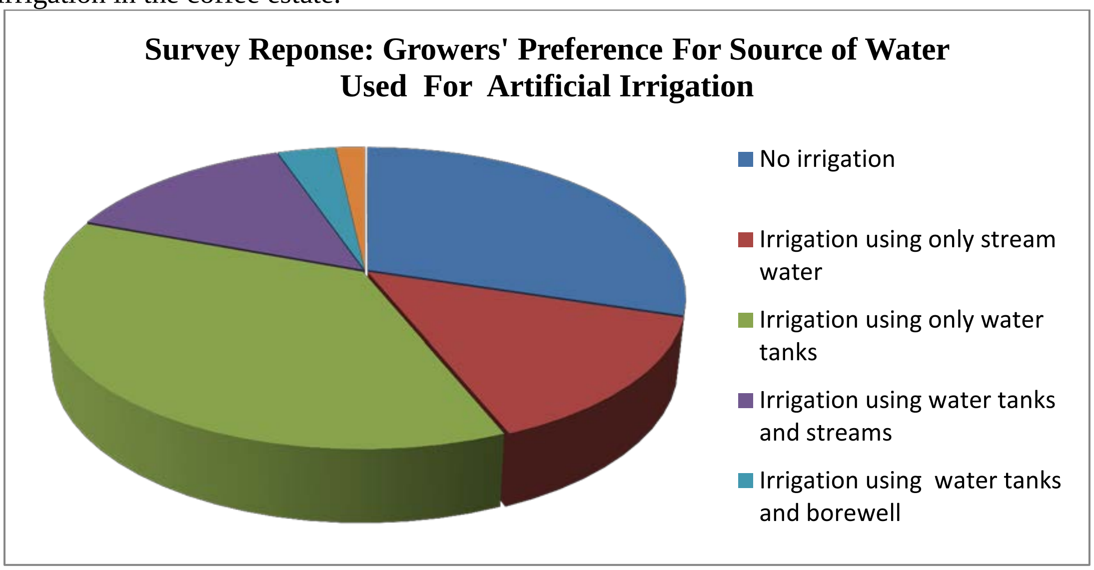
b) The total number of heads or sprinklers installed matter as that would decide the number of engines and motors required.

c) The compactness of the estate. An estate which is shaped as a strip and is not a square or round is probably going to incur more cost.

d) The acreage planned to be covered in one round of irrigation. The larger the area covered more will be the fuel expenditure.

A regular supply of water is ensured through springs, rivers and reservoirs/ponds that are replenished during the monsoon months. In a survey I carried out with a group of 61 coffee growers from different coffee growing areas (largely from Karnataka) a clear inclination towards artificial irrigation is apparent with 70% of the group relying on sprinkler irrigation by harnessing water from a range of different sources.[11]

Graph 2: Pie chart showing the status of irrigation and different sources of water used for irrigation in the coffee estate.



Data source: Primary. The Survey was conducted on 18th January, 2015 at University of Agriculture and Horticulture Sciences, Shimoga University, Mudigere, Chikmaglure, Karnataka.

The maximum percentage of growers, I interviewed, used water tanks (55%), which are constructed and replenished by monsoonal showers. If these are available at a higher elevation than the estate blocks to be irrigated then the overhead irrigation is possible by gravity. Mr. Appaiaha, a grower in Boiker (North Kodagu), explained the benefits of having an estate that was downstream from the source of water.

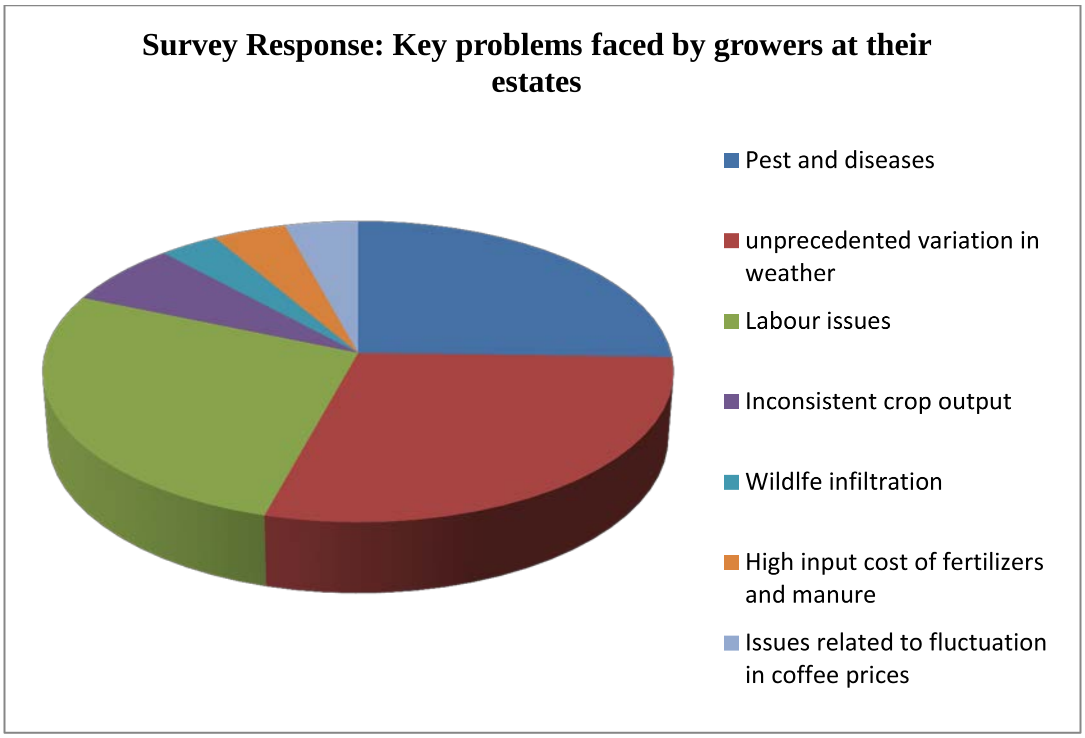
> In such a situation engines, pumps and motors can be dispensed with. Moreover irrigation can be carried out throughout the day as there is no disturbance associated with heating up or failure of engine or pumps.

[11] To see detailed list of survey respondents refer to annexure 5.

Additionally, fuel expenditure which incurs heavy cost is also saved. But positioning a water tank in such a location is not a feasible task.[12]

While carrying out my survey, I asked growers to list the top three problems or challenges they encountered in their estates. For most of the growers, they considered unprecedented variation in weather as their top concern and followed it closely with worries about the unavailability of labor.

Graph 3: Pie chart showing key problems faced by coffee growers at their estates.



Data source: Primary. The Survey was conducted on 18th January, 2015 at University of Agriculutre and Horticulture Sciences, Shimoga University, Mudigere, Chikmaglure, Karnataka.

Geetha Suresh, a grower in the Sakleshpur region, revealed to me her concerns over the vexatious issue of labor. To illustrate, she pointed out to me how another grower

[12] Mr. Appaiah, Silver Dream Estate and Home Stay , Ibnivalavadi village, Boikeri-571201, North Coorg, Karnataka. Interviewed on 7/1/15 at his estate.

having a much smaller acreage had recently rented out her washing unit for half a day.[13] Standing next to me and watching the grower couple unload their gunny bags full of freshly picked berries and emptying them in the washer, Geetha somewhat wistfully noted:

> This couple worked earlier as labor in the estates. I know them for very long. They have also worked on my estate. Hard working people. They saved money and eventually bought half an acre of land. I am sure if you do a detailed calculation about return on investment their's will be higher than mine. Not because of my heavy investment in fertilizer, irrigation or disease control but simply due to the timely availability of labor. There is an appropriate time to irrigate and to harvest if you miss that window there will be a net decrease in overall production. So if during blossom time you do not have sufficient labor to work the pipes, the delay will result in net decrease in total production. Though these people don't have an irrigation set up but labor is equally important for the timely harvest. In their case if required they will bring in their extended families and do the work themselves.[14]

The concern for the timely availability of labor was reflected in all the interviews and survey response because unlike other estate crops, in coffee, there are certain crucial points/windows in the crop cycle and during these delicate phases all the estates require labor at virtually the same time. Availability of labor for irrigation, in effect, is as serious a concern as the availability of the water. Growers, hence, need to grapple as much with getting the technologies for artificial irrigation set up as they have to also simultaneously

[13] Washing unit is used for processing the harvested coffee through wet method. In this method coffee is pulped on the same day after harvesting. The pulping process requires supply of running water and is hence called wet method.

[14] Geetha Suresh, Jaladarshini Estate, Bykere Post, Saklespur *Taluk*, Hassan district, Interviwed on 5/12/11 at her estate.

ensure that they have the right amount of labor to maneuver the pipes and other aspects for carrying out artificial irrigation.

Rain-guns as the saving of labor

Even though sprinkler irrigation is an appealing and obvious strategy with which the grower can reduce losses from the variations in rainfall, a range of contingencies, I point out, especially that of labor availability can end up limiting the success of this irrigation technology. As rainfalls become increasingly unreliable in terms of their arrival and quantum, concern about gaining more control over the contingent factors for coffee production have become a top priority. Dr. Anand Perriera, a coffee grower in Sakleshpur region, widely known for his sustained investment in irrigation, explained to me the broader issues involved:

> Over the years irrigation system used in coffee estate are the sprinkling set up (tanks + tubewells + engines+ pipes +sprinklers). These systems fail to consider the need to irrigate in a specified period of time. After all, time is the essence in irrigating the entire farm. In most cases the mainline supplying water to the lateral lines are undersized creating tremendous friction loses at the first step itself, resulting in overloading of the engine and pump. Also, in time of emergency, when there are unseasonal rains irrigation cannot be completed within the reasonable time window. Our experience is that sprinkler system are labor intensive and inefficient with regard to the expectation from irrigation systems in today's time. [15]

Robusta growers, as I noted earlier, do not have to wait for the blossom showers with as much anxiety as the Arabica growers. Robusta coffee, in other words, it is widely held, can be matured or blossomed through a set irrigation schedule rather than having it dependent on the arrival of the rains. The increasing shift towards Robusta also perhaps

[15] Dr. Anand Pereira, Joe's Sustainable Farm, Kirehully Estate, Sundekere Post, Sakleshpura*Taluk* , Hassan District, 21/2/14.

explains why the rain-gun technology has ended up meeting the double expectation of saving labor and trying to reduce the dependence of the grower on the blossom showers.

Picture 28: Irrigation being carried out using rain gun at Mr. Basanna's estate in Sakleshpur Taluk, Hassan district Karnataka.

Rain-guns have two primary advantages: a) large quantities of water are sprayed over a vast distance within a short period of time and b) it is less dependent on labor management. Following is a quick comparison in the scale of operation between sprinklers and the rain-gun. Gemini is particular rain-gun known for wide range upto which it can throw water.

Table 9: A comparison between the scale of operation of rain-guns and sprinklers.

	Nozzle diameter	**Pressure (bar)**	**Pump discharge (liters per minute)**	**Jet throw (radius in feet)**	**Irrigated area (ft^2)**
Rain gun (Gemini)	34mm	4.90	3000	210	138544
		5.9	3000	225	159043
Sprinkler	12-13mm	0.01	11	39	4778
		0.02	14.61	41	5281

Source: Data for the Gemini raingun is obtained from Dr. Anand Pereira and Dr. Geetha N. Pereira (2009), Ecofriendly Coffee, volume (1), p.137. Data for sprinklers is obtained through primary interviews.

The key concern or risk, nonetheless, associated with artificial irrigation remains the issue of the timing of the rain. If the coffee berry blossoming is induced through artificial irrigation but quickly followed by the blossom showers then the matured berries would be affected by this excessive burst of moisture and thus the total output would decline. In the case of one particular estate, I witnessed how the overlap of rains and irrigation caused a bloated berry blossom with thick plant petals and resulted in a much damaged crop. With heavy irrigation followed by rain, moreover, growers also pointed out that the plant pollen was found to be too moistened and not easily blown off for successful pollination of the coffee flower.[16]

The rain-gun technology ─ irrigating maximum area in minimum time and aimed at entirely substituting dependence on natural rainfall ─ however, brings in a second order of vulnerabilities for the grower. That is, the growers with rain-gun irrigation are now required to dodge the blossom showers in order to save their coffee crops. And consequently getting the rainfall forecast (weather forecast) right has become even more critical to coffee growing than the earlier anxious wait for the blossom showers.

[16] S.R. Gopalan (1974), A Review of Irrigation in Coffee, *Indian Coffee,* p.48.

Insuring for crop loss

The Rainfall Insurance Scheme (RISC) was introduced in the coffee growing belts of South India in 2007 -2008. One of the features of this scheme is that a specific meteorological station is identified as the reference station. In order to reduce moral hazard[17] the scheme requires that its rainfall data is drawn from a standard set of rain gauges known as the Reference Rain Gauge (RRG) and the Telemetric Rain Gauge (TRG) and these readings are monitored by the Karnataka State Disaster Monitoring Cell (KSNDMC), National Collateral Management Services (NCMSL) and the Indian Meteorological Department (IMD). Each RRG and TRG is allocated and intended to cover a specific number of villages. This allocation is, however, the prerogative of the Coffee Board which it decides on in consultation with the AIC. At present there is one main RRG and one back up RRG per Hobli.[18]

The distance between a coffee estate and the corresponding RRG is of significance for the RISC payouts. In the mountainous terrain of Western Ghats it is highly likely that the amount of rains received at a particular estate and the corresponding RRG are not the same. This difference in how precipitation is measured from the actual rainfall impact experienced on the ground gives rise to what is termed as the basis-risk. It refers to the difference between the rainfall observed within an estate and the rainfall recorded at the corresponding RRG. Often, the greater the physical distance between the RRG and the estate or between the observed rainfall and the recorded rainfall the higher is considered to be the basis-risk.

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[17] Moral hazard refers to the risk that arises when a party to a transaction has not entered into the contract in good faith and has provided misleading information about its assets, liabilities or credit capacity, or has an incentive to take unusual risks in a desperate attempt to earn a profit before the contract settles.

[18] A Hobli is defined as a cluster of adjoining villages in the state of Karnataka, India. This clustering of villages was formed mainly to streamline the collection of taxes and maintenance of land records by the revenue department of the state. Each Hobli consists of several villages and several Hoblis together form a Taluk.

In case of the Western Ghats, this basis-risk is further accentuated because of the highly variable local topography. The instance of Javali Hobli in Chikmaglur district is particularly instructive. Under RISC, there is only one reference station for Javali, which in turn is a subzone under the Kalasa zone in Chikmaglur district. The Kelagur, a company coffee estate spread over 1000 acres in Javali and which is owned by Mr. Peter Mathias is divided into three divisions, with each being treated as a separate measuring unit in itself. These divisions are primarily based on the micro-climate physical conditions such as rainfall received and relative elevation. According to Mr. Mathais, there have been several instances in which a generous rain enveloping one part of his estate was simultaneous with the other divisions in the same estate often receiving scanty showers. In other words, topography and different points within the same estate could have both a rainfall surplus and deficiency along the same temporal scale. Each division, hence, maintains its own weather records.

Table 10: Rainfall Record at Javali Hobli, Chikmaglur Taluk (March, April and May 2011)

Source	**Rainfall record for March, April , May 2011**
Division A Kelagur Estate, Javali	129 cms
Division B	147 cms
Division C	105 cms
KSNDMC Reference Station at Javali	238 cms

Source: 1) Kelagur Estate: Primary data obtained from the estate.
2) Karnataka State Natural Disaster Monitoring Centre (KSNDMC).

According to the Coffee Board website, Hassan district has 12 reference stations: 2 in Belur, 2 in Hanbal, 3 in R K Magee, 2 in Sakleshpur and 3 in Yeslur. Out of the two RRGs located in Sakleshpura, one is situated at Ballupet in the premises of a Primary Health Care Centre. The second is situated at Sakleshpura town in the premises of the Inspection Bungalow office. The two are separated by approximately a distance of 10-12 km. To these RRGs are then allocated specific villages.

RISC views and assesses rainfall within this geographic space through the data that has been compiled by the RRGs and TRGs. Following such a measurement protocol, the location of RRGs and TRGs is of prime importance. To specify how the location of these RRGs matter I have sought to compare data that I have picked up from four different sources for March - April 2011. Three out of the four sources are government records and one of them I have obtained from a private estate. The RISC payout for the same period in the Sakleshpura zone is mentioned. Rain fall in the month of March and April are covered under Blossom Shower coverage in RISC.

Table 11: Rainfall record for April 2011 from different rain gauge stations at Sakleshpura Taluk.

Source Station	**Rainfall Record in cms**	**Number of days**	**Payout given Under Blossom Cover of RISC**
RRG at Sakleshpura town	29	4 days	No payouts
RRG at Ballupet, Sakleshpura	No rainfall	-	Rs.9000
Coffee Board Extension Office at Mutsagar, Sakleshpura	8.8	6days	-
Anupama Estate at Halsulgue post in Sakleshpura	11.2	7 days	-

Source: Primary Data

The location of the RRGs and TRGs must be noted are not entirely decided by the insuring body (AIC) but rather by the 'respective authority', which monitors the station. In this case those authorities refer to the KSNDMC, NCMSL or the IMD. Within these agencies the rationale for installing a rain gauge at a particular location depends on its accessibility for carrying out monitoring and maintenance. In the case of the RISC the decision of a payout to an aggrieved coffee estate is thus based on the measurements of the station rather than on the actual impact within the coffee estate.[19]

Hence, there are several instances where a grower has not received sufficient rainfall on the estate but the standard rain gauge in the area has recorded the precipitation event as being normal rain. He/she thus does not get a payout and is compelled to bear

[19] To see detailed list of the location of Reference Rain Gauge network used for monitoring rainfall for RISC see annexure 18.

losses from both: the investment on the estate and for the premiums given for RISC. The reverse also does happen, where a grower actually receives the required amount of rainfall on the estate but the standard rain-gauge in the vicinity records it as being a below normal rainfall. In effect, I suggest here that it is not the weather event per se but the weather information that actually sets the template for deciding who has suffered and how much is that loss. Here vulnerability is not a function of rainfall, therefore, but critically depends on the contexts between the estate and their most proximate RRG.

Vulnerability and decision-making

In this chapter, I have thus far argued that in case of both these strategies ─ artificial irrigation and RISC ─ the growers' vulnerability is more a function of weather information rather than the weather event itself. In case of rain-gun irrigation, for example, I point out that the success of the irrigation exercise depends on the growers now being able to dodge the blossom showers, which they previously depended on. To avoid this overlap in irrigation and rainfall, weather information in terms of an accurate rainfall forecast becomes critical. In case of the RISC payout, one sees a similar dependence on the local RRG. How closely an RRG represents the rainfall observed on an estate, in fact, depends greatly on the physical distance between the estate and the RRG. Put differently, insurance payout is a function of the data generated by the rain-gauge network.

In the brief vulnerability assessment exercise that I carry out below, I review the decision-making process of the grower in order to explain how investment choices for artificial irrigation and RISC are made. The intention is to underline that as these strategies become increasingly dependent on meteorological information, growers, I indicate, appear to become increasingly reluctant to invest in artificial irrigation and RISC.

For this assessment of the grower's decision-making, I consider various investment situations in irrigation and insurance for both Arabica and Robusta growers.

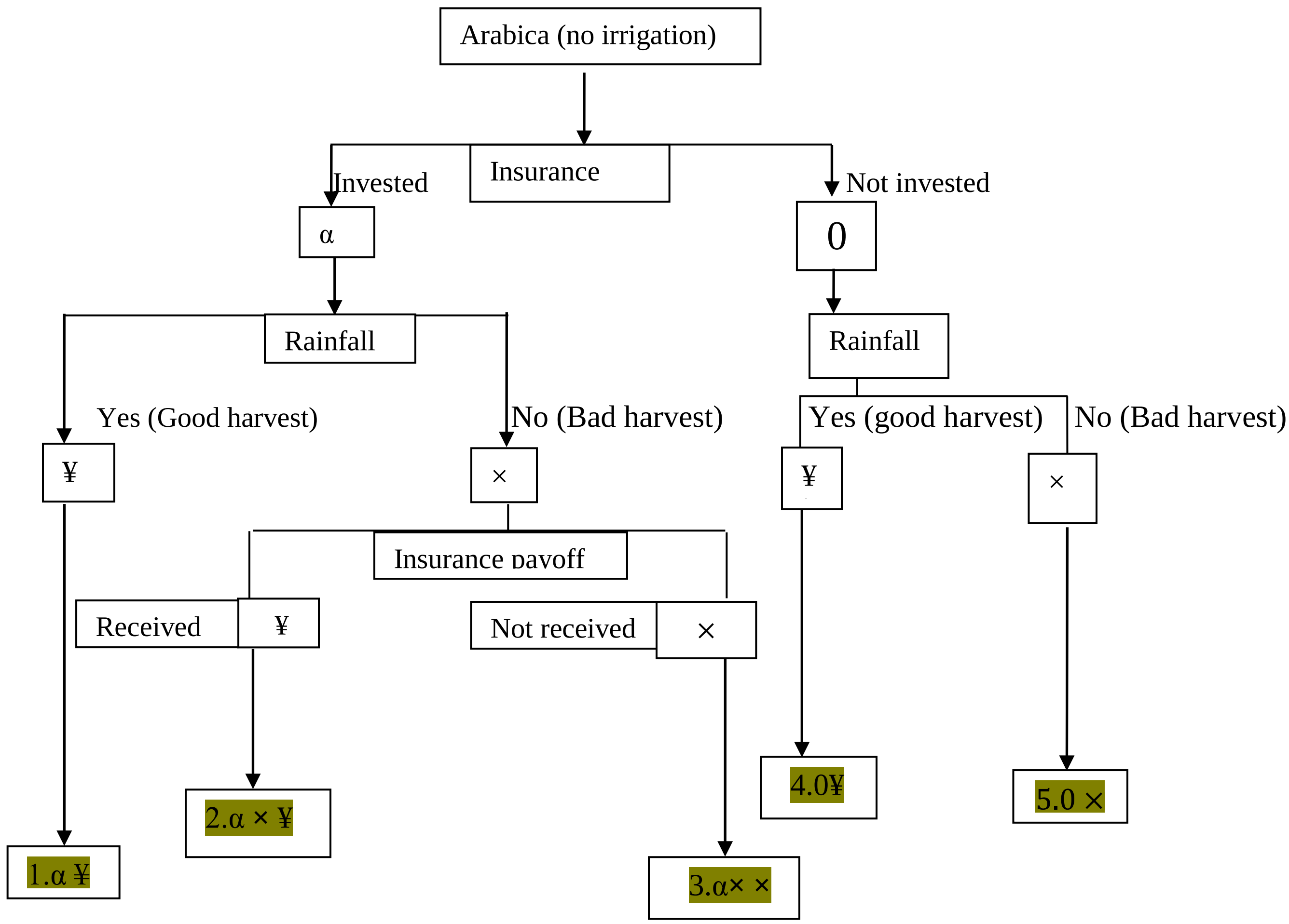
In the assessment process I follow a flow chart where a grower's choice to invest (in insurance and irrigation) would be represented by α symbol. The opposite i.e. his choice not to invest would be represented by 0 symbol. Returns received on investment in the form of good harvest or payout from the insurance scheme will be represented by ¥ symbol. Whereas the cases where grower is unable to receive returns and suffers a loss would be represented by × symbol.

Following is the quick guide to the symbols used:

a) α: investment made.
b) 0 : investment not made
c) ¥ : returns received.
d) × : returns not received.

Each chain of decision making will be followed through the flow chart till the end to calculate total number of α, 0, ¥ and × in every case. In the overall assessment more number of α will signify higher financial stakes. More number of × will represent failure in receiving returns on the investment. So a set of choices which eventually adds upto maximum number of α× would represent the most vulnerable situation. Whereas a combination of choices 0¥ will represent least vulnerability. In order to keep these assessments simple, loan cycle has not been taken in consideration. It needs to be flagged that loan further accentuates vulnerability and it is the investment in the schemes, technologies, fertilizers and pesticides for which grower take loans. In a way, investment in irrigation and insurance is partly reflective of the loan pressure as well.

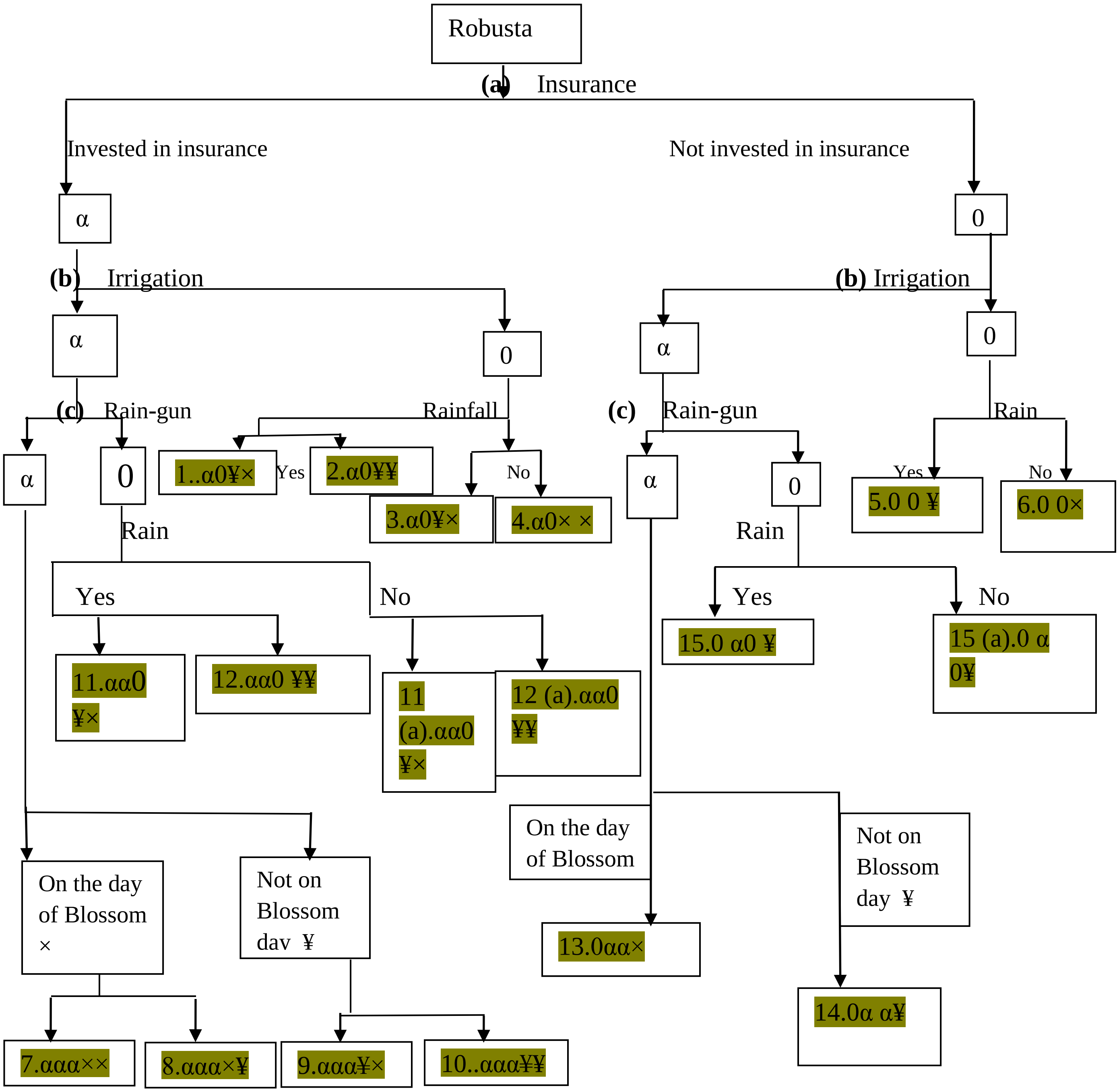
Figure 4: Flow chart representing Assessment of Arabica growers' vulnerability in terms of their returns on investment in insurance



1. α ¥: Grower gains from a good harvest but not from the investment made in insurance.
2. α × ¥: Grower losses crop but gains from the investment in insurance.
3. α × ×: Grower losses crop and his investment in insurance.
4. 0 ¥ : Grower does not invest in insurance and gains simply from his crop.
5. 0 ×: Grower loses crop due to rain failure. Makes no investment in insurance derives no benefit.

As the chart above suggests, the Arabica growers do not invest in irrigation because the plant has deep roots and does not respond well to artificial irrigation. Arabica growers, therefore, are and chose to be essentially dependent on rainfall. In the assessment for Arabica we have, hence, not considered artificial irrigation as an investment option. In the above Assessment, the Arabica grower number 3rd would be most vulnerable and 4 would be least vulnerable. The 3rd grower received minimum returns on his investment whereas the 4th grower received the maximum returns on his investment. The 3rd grower invested in insurance, suffered a loss due to failed rainfall and did not receive compensation due to basis risk problem in the scheme. Whereas 4th grower did not invest in insurance. The rains, however, performed as per expectations and he received returns more than the investment he made. In case of Robusta this calculation is still trickier because majority growers have invested in irrigation and a few of them have gone a notch higher and invested in rain guns. Rain-guns, as explained in the previous section, work on a scale where they can potentially replace the rainfall.

Figure 5[20]: Flow chart representing assessment of Robusta growers' vulnerability in terms of their returns on investment in artificial irrigation (sprinklers and rain guns) and insurance.



[20] The detailed key to the symbols used is attached at the end of the chapter.

The flow chart has three decision making stages for a grower. In stage (a) grower chooses whether to invest or not to invest in insurance. In stage (b) the decision is to invest or not to invest in irrigation. After these 2 stages of decision making we have arrived at 6 possible end situations that a grower might find himself in. The description of these 6 end situations are provided in the later part of the chapter.

The third stage of decision making (c) is open to growers who decided to invest in irrigation at the second level of decision making. At the third stage the 'yes' or 'no' choice is between investing or not investing in rain guns. A grower who decided to invest in irrigation but not to invest in rain-gun irrigation has invested in sprinkler irrigation. The third stage of decision making result in 12 more end situations. The description of these 12 end situations are provided in the later part of the chapter.

As mentioned previously:

A situation with maximum number of α× represents no returns on investment.

A situation with maximum number of α¥ represents good returns on investment.

A situation with maximum number of 0¥ represents returns on minimum or no investments.

Maximum number of 0× represents a no investment no return situation.

To read the vulnerability assessment chart better we look at six end situations. The first two situations are 7 & 10. Situation7 represents maximum loss and situation 10 represents maximum profit. Most interestingly the same sequence of decision making on growers part has resulted in both the situations. In both cases grower has decided to invest in insurance and rain-gun irrigation. In situation 7 a misleading rainfall forecast results in receiving rains on the day of blossom showers. Additionally basis risk has worked against the grower. In situation 10 along with forecast basis risk also works in growers favor. i.e the rains were received but the nearest rain-gauge did not record it and grower gets a payoff. Therefore the factors that decides which way growers' decision is going to swing between these two extreme situations depends on the meteorological information about the rainfall.

Least vulnerable are situation 5 & 6. In both case growers have made no investment in either of the two strategies. There is no dependence on meteorological information of rainfall. In situation 5 certain amount of rainfall is received leading to a crop harvest. In situation 6 no rains were received and hence no crop harvested. While in both cases rains is still not predictable but vulnerability in terms of returns on investment and dependence on weather information is zero.

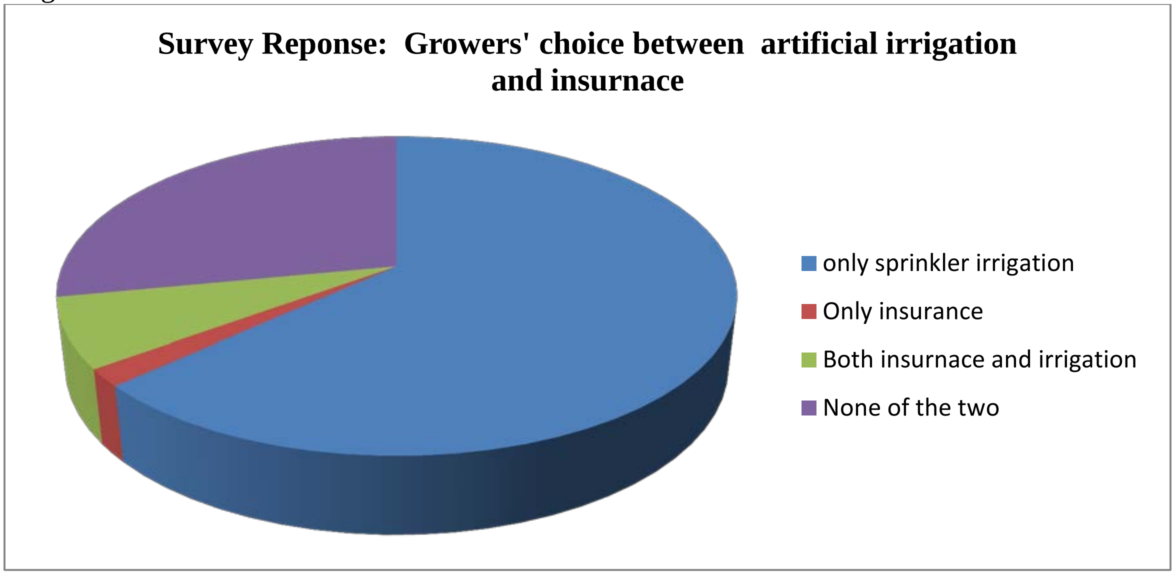
The next set situations in focus are 15 and 15 (a). These are two sets of situations represented by same combination of symbols (0α0¥). In both these situations grower has chosen not to invest in insurance. In both cases grower has invested in sprinkler irrigation. While in situation 15 the rains came in situation 15 (a) rains didn't come. In one case good crop is harvested in the other case below average crop is harvested. But in either of the cases heavy investments are not made in rain-guns. Their vulnerability is less. The limited set of vulnerability experienced is a function of rainfall and not weather information about rainfall.

According to this vulnerability assessment most preferred situation in terms of least vulnerability are:

a) situation 5: investing in none of the two strategies
b) situation 15: investing only in sprinkler irrigation

Least preferred situation in terms of maximum vulnerability is situation 7 investing in insurance and rain-gun irrigation simultaneously. This sequence of preference arrived at by vulnerability assessment is validate by growers response to a written questionnaire. Following pie chart is made based on growers' response

Graph 4: Pie diagram showing survey response of growers towards their choices regarding irrigation and insurance.



Source: Based on primary field work.

Here the most preferred categories are a) only sprinkler irrigation b) investing in none of the two strategies. Growers have automatically chosen the least vulnerable combinations in terms of returns on investment thus validating the vulnerability assessment carried out above.

Concluding remarks

In chapter 4, I suggested, following my field work, that there appeared to be three distinct perceptions about rainfall that often complicate decision making in the coffee estates of South India. These perceptions can be outlined as: a) the growers' situated experiences of rainfall b) the meteorologists' perception informed by models and temporal boundaries and c) the insurer's narrative that is assembled by statistical patterns based on long term rainfall data trends. These differing perceptions about rainfall impacts, timings and significance for the coffee plant, I also emphasized, did not always converge for decision-making exercises or practices with regard to growing coffee.

In Chapter 5, I further explore how these distinct rainfall perceptions play out with regard to two crucial decision-making exercises, notably: artificial irrigation and the coffee crop insurance scheme (RISC) in the coffee belts of the Western Ghats. While carrying out artificial irrigation through sprinklers and rain-guns requires the grower to have constant and credible rainfall forecasts, implementing the coffee crop insurance scheme (RISC) necessitates his understanding of the various meanings from the careful and rigorous collection by meteorologists of rainfall data gathered through the network of rain gauges.

In thus exploring how these differing perceptions about rainfall constrain and determine the growers ability to respond to rainfall variation in her/his estate, I point out that the latter's crop loss and financial vulnerability in fact has actually increased. In large measure, I suggest that this growing vulnerability is a result of the fact that both artificial irrigation and coffee crop insurance schemes have begun to overtly rely or are shaped by weather information rather than on the weather event per se. That is, rainfall as recorded data and how it suggests broad statistical patterns have acquired more authority and legitimacy in decision-making rather than the experiences of rainfall of the coffee grower.

Key to symbols used in the vulnerability assessment of Robusta coffee growers.

1. **α0¥×** a grower who invests in insurance but does not invest in irrigation. Rains have performed normally in this scenario. While for him insurance does not trigger but he receive returns on investment by harvesting a good crop.
2. **α0¥¥** a grower who invests in insurance but does not invest in irrigation. In this case, rains did perform. Grower harvests the expected crop. In this scenario basis risk works in his favor. He received payout because his standard rain gauge recorded shortage of rainfall whereas he did not.
3. **α0¥×** a grower who invested in insurance but did not invest in irrigation. In this case rains did not perform but he gets compensated through insurance.
4. **α0× ×** a grower who invested in insurance but did not invest in irrigation. In this case rains did not perform but he does not get compensated by insurance because basis risk worked against him. i.e. While he did not receive sufficient amount of rainfall his standard rain gauge reported recording minimum rainfall required.
5. **00¥** a grower who did not invest in insurance and irrigation but rains received and he harvested a good crop.
6. **00×** a grower who did not invest in insurance and irrigation and rains also failed. He loses his crop.
7. **ααα××** a Robusta grower who has invested in insurance. He decides to invest in irrigation as well. For irrigation he has opted for rain-gun technology. In this situation rains perform normally. However, rainfall is received on the day of blossoming. Rain-guns result in entire estate blossoming at the same time. grower incurs heavy losses in blossom (which is eventually crop loss) due to rainfall. Additionally, insurance does not fill in for the crop loss because Rain gauges have reported rainfall. He loses invest in irrigation, insurance and crop.
8. **ααα×¥** In this situation grower has made same set of decisions as previous situation. Rains have performed. Only difference is that insurance got triggered.

By chance the RRG did not record the rainfall. This time basis risk has worked in favor of the grower.

9. **ααα¥×** This situation is similar to above two situations but not same. The grower has invested in insurance and rain guns. Rains have performed as expected and the rains did not coincide with the blossoming day. Insurance was not triggered.
10. **ααα¥¥** This situation provides an interesting counterpart to situation 7. Here grower has made exactly the same set of investment decisions as situation 7. But unlike situation 7 where grower suffers maximum loss in this situation he draws maximum returns. Rains did not coincide with blossom. Insurance gets triggered because basis risk works in favor of grower.
11. & 11 a) **αα0¥×** These are two sets of situations represented by same combination of symbols. In both cases grower has made same set of decisions. Grower invested in insurance and in sprinkler irrigation. In Situation 11 rains were received where as in situation 11 (a) rains were not received. In both cases grower was able harvest a crop but in 11(a) he harvested less crop. In sprinkler irrigation receiving rains on the day of blossom is not a cause of concern. So that contingency is not accounted for in this situation. In situation 11 insurance recorded the Absolute quantity of precipitation and hence payout is not given. In situation 11(a) basis risk kicks in and grower is not given a payout.
12. & 12 a) **αα0¥¥** Again two sets of situations represented by similar combination of symbols. In both cases grower has made same set of decisions. Grower invested in insurance and in sprinkler irrigation. In Situation 12 rains were received where as in situation 12 (a) rains were not received. In both cases grower was able harvest a crop but in 12(a) he harvested less crop. In situation 12 basis risk kicks in and grower is given a payout despite the occurrence rainfall. In situation 12 (a) insurance aptly recorded the failure of rainfall and hence payout is given.
13. **0αα×** Grower who has not invested in insurance. He decides to invest in irrigation as well. For irrigation he has opted for rain-gun technology. In this situation rains perform normally. However, rainfall is received on the day of blossoming. Rain-

guns result in entire estate blossoming at the same time. Grower incurs heavy losses in blossom (which is eventually crop loss). Insurance plays no role here.

14. **0αα¥** This situation represents two real life situations. Grower who has not invested in insurance. He decides to invest in irrigation as well. For irrigation he has opted for rain-gun technology. In one situation rains come but not on the blossoming day and in the other situation rains don't come. In either case crop is not affected.
15. and 15 (a) **0α0¥** These are two sets of situations represented by same combination of symbols. In both these situations grower has chosen not to invest in insurance. In both cases, however, grower has invested in sprinkler irrigation. While in situation 15 the rains perform in situation 15 (a) rains don't perform. While in one case good crop is harvested in the other situation below average crop is harvested

Chapter 6

Calculating Rainfall
Weather Monitoring and Forecasting

This chapter discusses how growers' generate meanings about rainfall and how they interpret weather forecasts for growing coffee. The grower's strategy for reading rainfall, I suggest, moreover, appears to be markedly different than that of how trained meteorologists and their organizations such as weather monitoring stations understand rainfall and forecasting. In part, the meteorologists, I will argue, pursue and sustain standardized protocols for forecasting and understanding rainfall which does not always overlap with how growers attempt decision-making for cultivating coffee from their situated perceptions about rainfall.

Growers and the rainfall forecast

Artificial irrigation either through sprinklers or the rain-gun, as I have pointed out in the earlier chapter, is critically important for growing the Robusta variety. In large measure, according to the growers who I interviewed, the Robusta owing to its shallower roots tends to respond more positively than the Arabica variety to controlled artificial irrigation. A Robusta grower thus can institute a fixed schedule for irrigation beginning from mid to late February. If and when Robusta growers actually check the weather forecast what they are looking for are: a) weather on the days when irrigation is to be carried out and b) weather on the days when blossoming is expected from irrigation. Besides these two critical assessments, the weather forecasts do not hold much more value for the Robusta growers. On the other hand, for Arabica growers the timing of the rains for the blossom showers are absolutely crucial and they have to anxiously follow forecasts. These two sets of growers (Robusta and Arabica), one therefore notes, choose and understand their sources for weather information differently.

For instance H.R. Prasad, a grower in Halsuligue village of Sakleshpur Taluk, who grows both Arabica and Robusta varieties alongside his estate-records of the rainfall (maintained since 1985) also regularly monitors satellite weather images printed in the weather forecasting column of the national daily newspaper. Prasad, just like many other growers, I realized, seemed to be quite circumspect about the weather forecasts of the IMD and upon being asked why he needed to study the satellite pictures, he replied:

> By observing cloud movement in the pictures we can make a fairly good guess when the rains will hit the interior parts of Karnataka.[1]

Yet another grower, M.V. Nandan, located in the same agro-climatic zone as H.R. Prasad estate, measures rainfall regularly but only by recording it as a somewhat casual scribble on his calendar. He too did not think highly of the IMD and instead glowingly endorsed the British Broadcasting Channel (BBC). On the surface while Nandan seemed to have a different strategy than H.R. Prasad, there appeared several commonalities. Nandan kept a close watch over the BBC weather satellite images, which for him clarified with an arrow system the possible direction in which clouds were expected to move. By thus simply observing these satellite pictures, Nandan claimed that he could more or less accurately guess the arrival of rains for the southern interior portions of Karnataka.

Another source of information that is widely subscribed to by growers for weather forecasting is the internet. The two most cited websites are www.accuweather.com and www.weatherbug.com. Both websites provide worldwide coverage of weather information. Weatherbug.com even provides weather details up to the Hobli[2] level in India. Together with temperature it mentions wind speed, humidity and the dew-point.[3] It

[1] Interview with H.R.Prasad, 22nd November 2011, Anupama Estate, Halsuge village, Sakleshpura, Hassan.

[2] A hobli is defined as a cluster of adjoining villages in the state of Karnataka, India. This clustering of villages was formed mainly to streamline the collection of taxes and maintenance of land records by the revenue department of the state. Each hobli consists of several villages and several hoblis together form a taluk.

also provides a static satellite picture for the Asian region. Accuweather.com on the other hand, provides detailed information for metro cities only, though it also provides a very fine satellite image which is juxtaposed with the moving cloud pattern in the area.

Another, though uncommonly used method for monitoring weather that I chanced upon was in Tej Thimaya's estate at *Pollibata* (Virajpet district, South Kodagu). He had his own weather monitoring unit that was located within his sprawling coffee estate. All weather updates were directed to his mobile. But again, this was a small set up and was used for predicting weather for a day or the maximum of two.

Growers, I observed, used different sources for weather information and often followed up and compared between more than one source. Their list for weather related information spanned a range from internet websites, newspapers and several electronic news channels. Undoubtedly, all these sources of weather information provide precipitation details for large geographical territories, without aiming to speak directly to a particular locale, situation or topographical quirk. Consequently, it would be perhaps correct to conclude that such kinds of weather information templates are rendered into interpretative sites by the growers from which local and situated readings are carried out.

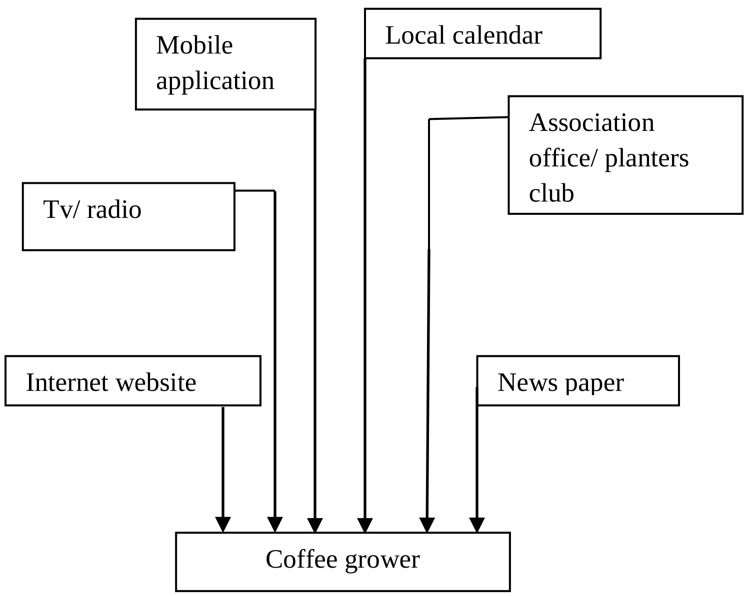
A Robusta grower would generally subscribe to several internet websites and mobile applications for a 5-7 day rainfall information spread, whereas an Arabica grower would look at the local calendar[4], satellite images in the newspaper or the information put out by the association offices. Clearly, to me, it appeared that the growers, in the main, followed a rough rule of thumb understanding about rainfall forecasts and even when they consulted precipitation data and satellite images these sources were turned into interpretative texts of sorts that were embellished with situation and context generated meanings.

[3] The dew point is the temperature below which the water vapor in a volume of humid air at a constant barometric pressure will condense into liquid water.

[4] For more on local calendar see annexure 17.

The flow chart below provides an overview of the information flows that are relevant for growers.

Figure 6: Flow charts showing the network of weather information in the coffee growing areas.



The meteorologically successful rainfall forecast

In contrast to the growers rule of thumb, interpretative and situational sense of rainfall, the meteorologists followed standardized protocols and formal institutional organizational logics for recording and conveying rainfall forecasts. Meteorologists work with Numerical Weather Prediction (NWP)[5] models, which essentially are the systematic ways for reconstructing weather environments at various spatial and temporal scales. There are different models, moreover, depending on the ranges and regions for which the

[5] NWP is based on a set of numerical equations of motion and state. For any given individual parcel of air, these equations describe how mass, momentum, energy and moisture are conserved during parcel's interaction with neighboring parcels. Numerical models function by using a grid scheme. A grid is an array of points used in representing meteorological data. The value a grid point holds is the average of all of the values found within that grid square. A higher number of grid points imply a shorter distance between points, and thus a better resolution. High resolution is critical when longer performance of a model is of extreme significance.

forecast is being made. There are global models for the medium range forecasts (4-10 days), a regional model for short range forecast (12 hours to 3 days) and a meso-scale model for a very short range forecast (up to 12 hours). During my interview of Dr. Raghvendra Ashrit at National Centre for Medium Range Weather Forecasting (NCMRWF), he clearly spelled out that:

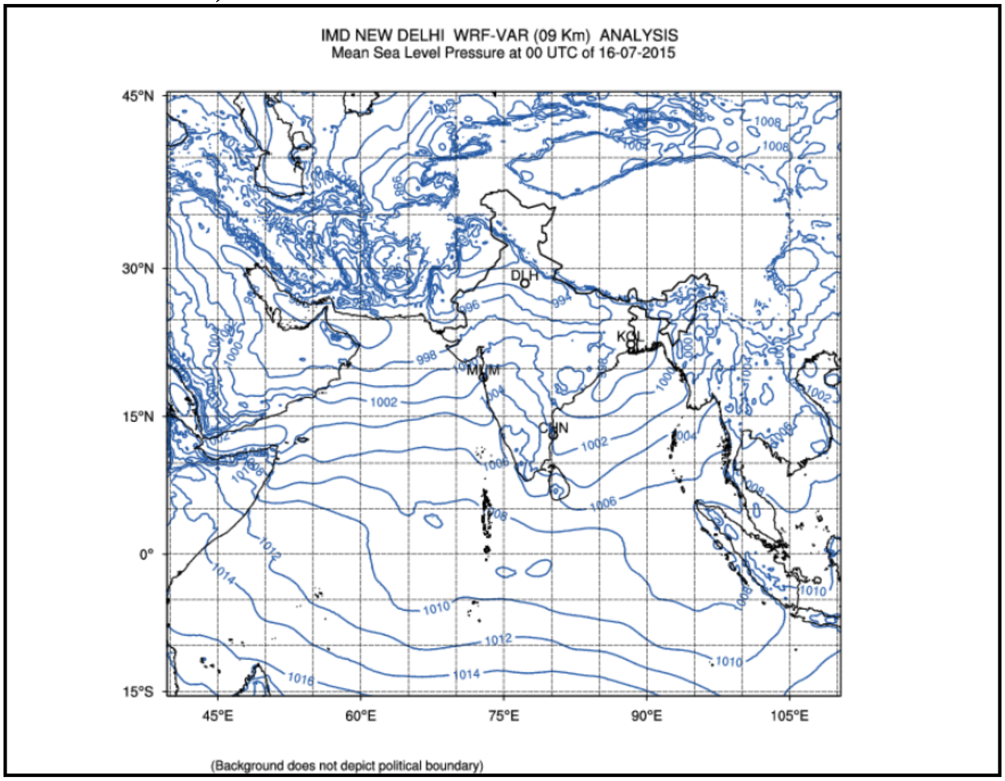
> Models are not magic crystal balls that reveal weather of a future moment in time. Starting from an initial set of conditions we are provided with *n* number of possible projections depending on which spatial and temporal construction we are looking at.[6]

The 'initial conditions' refer to the current state of the atmosphere and includes data about wind, temperature, clouds and other related parameters. At present the model used by the IMD for short range forecasts is the Weather Research and Forecasting (WRF) model. Using this model, 168 weather charts are generated every day, which are readily accessible on the IMD website. A weather chart (see picture 35, below) is put out as a series of undulating lines resembling waves hurtling through space. That the fluctuations of weather are the result of travelling waves has been a major foundation of weather prediction over many years. The most difficult part of a meteorologist's work is to delineate the wave which needs to be traced. It is a challenge because different waves are constituted in different frames of space and time.[7]

[6] Dr. Raghvendra Ashrit . Interview at NCMRWF Library, 24/11/2014 at 11.30 a.m.

[7] P.K. Das (1968), *The Monsoons*, National Book Trust, p.136

Picture 35: A weather chart showing NWP product of WRF analysis at 9 km resolution (nested domain) and Mean Sea Level Pressure at 00UTC on 16-7-2015.



Source: IMD website http://nwp.imd.gov.in/wrf9pro.php (8/8/2014)

The difficulty level is further accentuated by continuous interactions of these waves amongst each other. The waves that can be traced depend on the monitoring equipment available to capture that particular space and time frame or scale. However, which wave needs to be traced depends on the range of forecast expected from it: short range forecast, medium range forecast or long range forecast. Considering changes in climate might as well be thought of as waves whose period are of the order of decades or hundreds of years. Observational data is gathered through three different sources: Satellite Images, Automatic Weather Stations (AWS) and Automatic Rain Gauges (ARG).

Everyday weather forecast in the newspaper is accompanied with a satellite image of the country. A quick peek at the IMD website shows a whole buffet of satellite images[8]. They are used for gathering observational data for areas where weather stations cannot be maintained for instance ocean surface. For making observations on the ground there is a network of 559 conventional manned surface observatories established by IMD at every 100-200 km spatial distance. To support these conventional observatories there are another 550 Automatic Weather Stations (AWS) and 1350 Automatic Rain Gauges (ARGs) installed in different states. The data from AWS and ARGs are regularly updated on IMD website. Given below is an overview of the number of AWS and ARGs located in coffee growing districts visited for this study:

Table 13: The number of IMD installed and operated AWS and ARGs located in coffee growing districts visited for this study.

District	Number or ARGs	Number of AWS
Chikmaglur	1	2
Kodagu	0	1
Hassan	0	0
Dindigul (Tamil Nadu)	2	2

Source: http://www.imdaws.com/ (19/7/2015)

Given the limited the number of ARGs installed by IMD, the AIC also uses the Reference Rain Gauge (RRG) network of the Karnataka State Disaster Management Cell (KSNDMC) and the National Collateral Management Services Limited (NCMSL). Given below is the list of RRGs installed by KSNDMC and NCMSL in the coffee growing areas.

[8] These images are obtained from satellite Kalpana -1 which is first dedicated meteorological website by Indian Space Research Organization (ISRO). The satellite features a Very High Resolution scanning Radiometer (VHRR), for three-band images (visible, infrared, and thermal infrared) with a resolution of 2 x 2 km, and a Data Relay Transponder (DRT) payload to provide data to weather terrestrial platforms.

Table 14: The number of Rainfall Rain Gauges (RRGs) installed and monitored by KSNDMC and NCMSL.

District	Number of RRGs (KSNDMC)	Number of RRGs (NCMSL)
Chikmaglur	9	11
Kodagu	11	15
Hassan	7	5

Source: From the list of RRGs being used by Agriculture Insurance company (AIC) for Rainfall Insurance Scheme.

The data gathered from satellite images, ARGs and AWSs constitute ground observations for a meteorologist. To access the success of a forecast, ground observations and model forecasts are compared using statistical tools. One of the statistical tool used is the Mean Absolute Error (MAE). The MAE is the measure of how close the observed values are to those of the modeled ones. Following is the mathematical formula for calculating MAE.

$$MAE = \frac{1}{N}\sum_{i=1}^{N} |x_{pred} - x_{obs}|$$

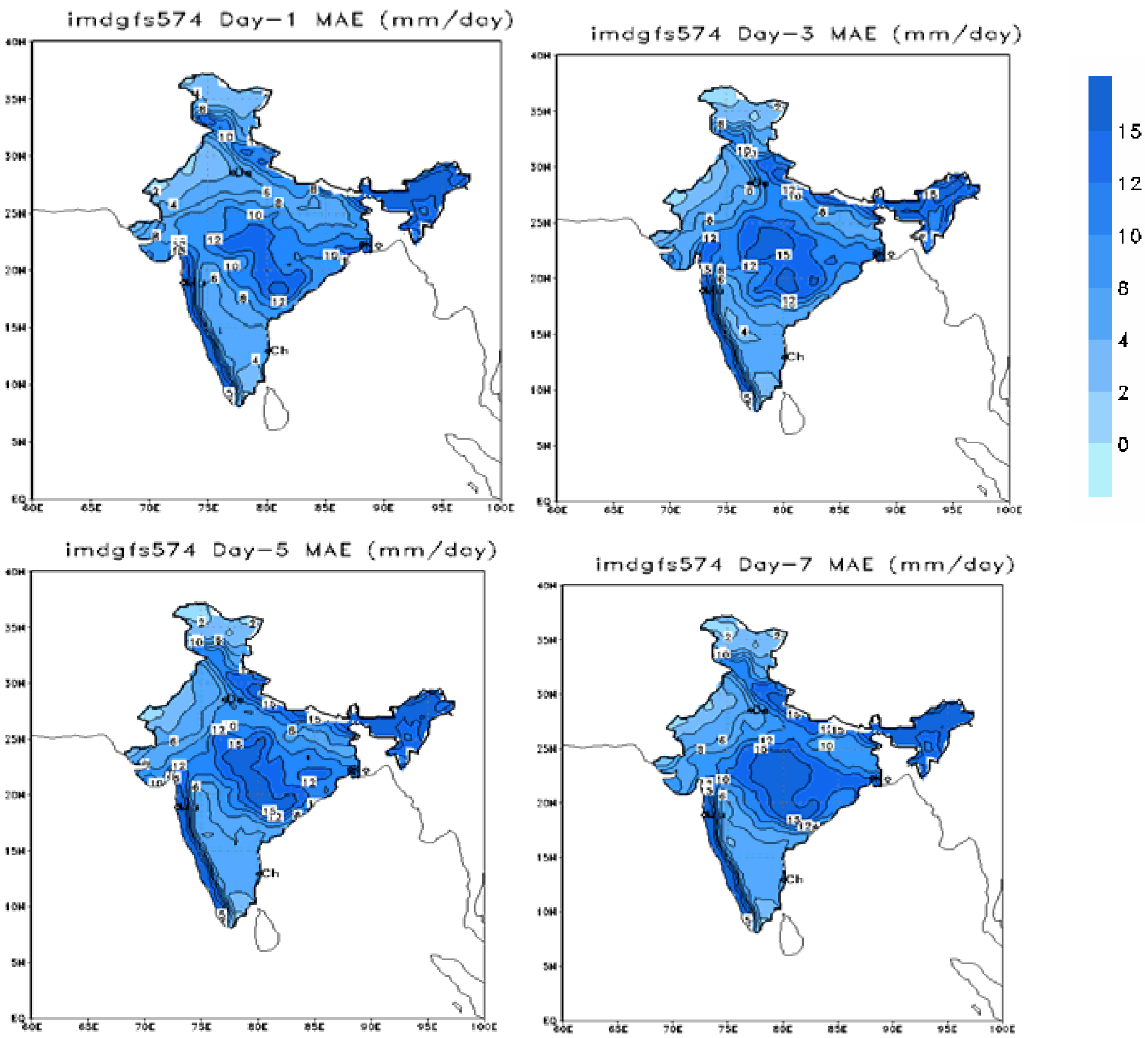
In this formula, N is number of points on which comparisons are made.

X_{pred} : Forecast values for these points.

X_{obs} : Value of ground observations for these points.

In order to make the absolute value of forecast comparable with the absolute value of ground observations the two data sets are smoothened to arrive at the data resolution of 50 kms. The MAE values thus obtained can then be represented diagrammatically. Following is a diagrammatic representation of the Mean Absolute Error for day1, day 3, day 5 and day 7 forecasts over Indian monsoon region over the period of 1 June to 30 September 2013. Day1, day 3, day 5 and day 7 represents the temporal resolution at which forecasts are made. Day 1 is 24hr forecast, day 2 is 48hr forecast, day 3 is 72 hr forecast, day 5 is 120 hr forecast and day 7 is 168 hr forecast.

Picture 37 : Monthly (June, July, August and September) Absolute Mean Error (MAE) (mm/day) of GFS T574 Day 1, Day3, Day5 and Day 7 Forecast over Indian monsoon region of monsoon 2013.



Source: S. K. Roy Bhowmik, V.R.Durai, Ananda K. Das, S.D. Kotal and M. Rathee (2014), Performance of NWP Models for Short Rnage and Medium Range Weather forecasts, *Monsoon Report 2013*, D.S. Pai and S.C.Bhan (eds), p.110.

In this diagram shades of blue represent the values of MAE. Darker the shade of blue higher is the value of MAE. Higher the value of MAE means greater the difference in forecast and observation. Put differently, darker the shade of blue higher is the error in forecast. Western Gat belt which is the study area for this work is represented by a dark shade of blue indicating that monsoon forecast made here were meteorologically not very successful for year 2013. Meteorologists calibrate their models for producing successful rainfall forecast based on the value of MAE. For meteorologists, if the value of MAE is zero (or the appropriate shade of blue has been achieved) the forecast is successful and model has performed as expected.

For meteorologists, as is evident from the brief discussion above, the rainfall forecast is a standardized procedure of using different models, observation networks (including satellite images) and statistical assessments. They model rainfall forecasts and measure the predictability of their assessments by collecting data from their rain- gauge networks. In sum, the meteorologists' perceptions about weather behavior appear to be typical of what Donna Haraway terms as the God's-eye view. Clearly the meteorologists perceive and understand rainfall in starkly different ways than the grower's notion of situated experience

Concluding remarks

This chapter explores the meaning of successful rainfall forecast for coffee grower and meteorologists. How a grower perceives a rainfall forecast depends on what he expects to draw from the forecast. For instance, while an Arabica grower is following the arrival rains, Robusta grower is following forecast to check whether the planned irrigation days and blossoming days coincide with the rainfall. Growers pick and choose the source of information depending on their specific requirement. For the grower success of forecast depends on the autonomy of interpretation.

Meteorologists on the other hand understand a forecast though formal, institutional and structured system of perceiving rainfall as precipitation in terms of absolute numbers. For them the success of a forecast depends on the performance of certain statistical tools. The effort, in the main, is directed at getting the desired answer from statistical calculations. If the value of MAE is Zero then it is a meteorologically successful forecast but meteorological success provides no understanding of the forecasts' usefulness on the ground. The chapter thus attempts to flag the difference between meteorological success for a rainfall forecast and the usefulness of that forecast for decision-making in a situated context on the ground.

Chapter 7

Bulls, Bears and Rainfall

In this chapter, I discuss how growers' contend with new financial and coffee output vulnerabilities as they try to negotiate an overwhelmingly meteorological information based approach with market calculations and speculative behavior. As pointed out in an earlier chapter (5), decision-making for the growers with regard to implementing artificial irrigation and insurance schemes (RISC) critically depend on rainfall forecasting methodologies, which in turn depend on how rainfall data is systematically collected from rain gauge networks. Consequently, the coffee grower, as also explained in the earlier chapter, is mostly constrained from responding to the rainfall event per se with his/her situated knowledges ─ which I furthermore underlined as being relatively more sensitive to understanding the implications of rainfall variation within the micro-topography and the local contexts of the coffee estate.

In effect, this chapter will illustrate how decision-making for coffee growing in South India ─ marked by a shift to an information based weather approach ─ is further complicated by different financial insecurities and coffee yield uncertainties as growers increasingly seek to or feel compelled to re-orient their market calculations and speculative behavior away from contending directly with rainfall as a weather event. Instead, rainfall variation is increasingly understood by growers as being a highly mediated moment by the science of meteorology with its modelled assessments and by the technical world of statistical precipitation created by rain gauge stations.

In an article published in 2010 in the issue of the *Indian Coffee* magazine, Dr. Jayaram the then director of Central Coffee Research Institute writes:

> It (coffee farming) should be considered as an activity operated for the purpose of earning a profit and to make a good living. Coffee growers like

> other businessmen, are also not without risk. The most important risk involved in coffee farming is the crop failure due to vagaries of weather, untimely showers, lack of dedication in men and field management and the occurrence of disease and pest. The crop failure may result in lowered production, reduced income, mismatch between investment and realization and thus inability to save.[1]

Clearly, as Dr. Jayaram highlights and makes the self-evident point that for a coffee grower the relation between financial investment and coffee output in an estate is critical and consequently any uncertainty that muddles this equation is of considerable importance. As a traded commodity the total coffee yield, however, is not the only core factor deciding on the financial returns for a grower. As is well known, a range of chance and complicated logics set commodity prices in the world today. No surprise therefore that a higher coffee yield per acre does not automatically translate into higher prices. Crop forecasts, hence, becomes an interesting entry point to understand the relation between what is termed as ‘speculated yield’ and the ‘realized yield’. Speculated yield refers to the yield a grower expects to harvest based on the investment made in the estate. ‘Realized yield’, on the other hand, is the actual crop harvested by the grower. It is equally important to understand how this relation between speculated and realized yields gets translated into various kinds of tangible risks or gains for coffee growers on the ground.

The Indian Coffee Board comes out with three coffee production forecasts during the course of growing year; these forecasts are neatly spaced out according to certain months for the growing and harvesting year.[2] The first is the <u>post-blossom production</u> forecast, which is published in the month of July. The second is the <u>post-monsoon production</u> forecast that is published around September – October and the third is the

[1] Dr. Jayarama (April 2010), Coffee Farming is a Business, *Indian Coffee*, LXXIV 4: 3.

[2] For more on coffee production forecast visit Coffee Board Website. http://www.indiacoffee.org/coffee-statistics.html (15/8/2016).

production forecast published in the month of January of the crop year. These production forecasts are understandably closely linked with assessments about rainfall. For instance, the post-blossom production forecast is based on the actual precipitation quantity of the blossom showers. For the second forecast, the actual quantity of the monsoon rainfall will help decide the post- monsoon production forecast and the final production forecast is based on how well the cultivation practices were followed and diseases and pest fought.

Growers, however, on occasion have showed discomfort and caution over the Coffee Board's production forecasts. According to an eminent coffee grower, 'the Coffee Board often overestimates the produce and forecasting is done at some random estate that is located nearest to a CCRI station, which then does not always reflect the picture of the entire coffee growing region.'[3] This opinion was in fact re-emphasized in various other interviews. But why should growers be concerned about their mid-season production forecast, I wondered, when their actual realized yield might even be better than the last year? Dr. M. Panduranga Vithal, Professor of Finance and Strategy at Indian Institute of Plantation Management (IIPM) in Bengaluru explained:

> Production forecasts are closely related to prices. Once a forecast estimates a good produce no trader or company would be worried that they will run out of coffee to buy. As a result the market tends to become increasingly bearish.[4]

A bearish market is a market where prices are falling and there is a kind of general pessimism in the air. The other kind of market is a bullish market. Here prices are rising and there is a positive expectation all around. By closely monitoring coffee market news, I was made aware that any persisting bearish tendency in the market had severe

[3] Based on the interview conducted in third round of the field work in 2015.

[4] Dr. M. Panduranga Vithal, from his interview at his office in IIPM campus Bengaluru on 4/2/15.

implications on the ground as coffee prices would stop rising.[5],[6] If this happens, especially with the post blossom estimates, an entire year's possibility of increase in price is halted. The speculated prices thus gets an unofficially stated or implied ceiling. Once that happens, there is then a tendency by coffee growers to steeply at times cut down on making investments in their estates. If the coffee selling prices are thus made sticky with a tendency to slide even further then the only way to increase the profit margin is to reduce investments. Needless to add, any drop in investment by the growers will directly impact the overall realized coffee output.

In a 2002 study by Nagarajaiah et al. — which studied the investment cost of 233 growers located in South Kodagu — it was concluded:[7]

- The low price situation forced the majority of the small growers to adopt cost reduction measures on farm expenditure. The extent of cost reduction measures moreover further depended on their socio-economic conditions and the size of their holdings.
- The extent of reduction in production was found to be directly related to the extent of the cost reduction measures adopted by the small growers. The level of reduction in coffee yield thus greatly depended on the reduction in critical inputs/ practices like manuring and irrigation.

[5] Emiko Terazono (May 5, 2015), Bears Feast on Strong Coffee, *Financial Times*. http://www.ft.com/intl/cms/s/0/782a0922-f330-11e4-a979-00144feab7de.html#axzz3v7wpPC00 (1/1/2016).

[6] Emiko Terazono (February 20, 2015) Coffee Prices slide as Brazilian rainfall recede, *Financial Times*. http://www.ft.com/intl/cms/s/0/442e781c-b909-11e4-b8e6 00144feab7de.html#axzz3v7wpPC00 (1/1/2016).

[7] N.V.Nagarajah, Ranjith Kumar, B. Shivaram, Sathishchandra & M.A.Kushalappa (October 2003), Impact of Low Prices on cultivation of Small Robusta Coffee Plantations in South Coorg, *Indian Coffee*. LXVII (10):21.

This behavioral trend they noted is also acknowledged by similar behavior in the international markets as well.[8] Depending on price trends, therefore, growers accordingly change their investment patterns which in turn have a bearing on the overall yield. The experienced coffee growers, in fact, can often pick early on whether there will be a downward trend (bearish market) or an upward trend (bullish market) and craft their investments accordingly. A good crop doesn't thus necessarily ensure high returns and similarly returns on a relatively poor crop can be salvaged by an upward movement in the selling price. Following table puts this relation in a tabulated form.

Table 14:A proposed relation between rainfall and speculated returns by the grower.

Performance of the rainfall	**Crop speculated**	**Impacts on prices**	**Impact on coffee estate**	**Returns speculated by the grower**
Rainfall does well locally. →	Estimates indicate possibility of a good crop in the production forecast. →	Prices are set because market demands can be met. →	Less incentive to add more inputs in order to improve the yield. Rather there is tendency to reduce inputs in order to increase the profit margin. →	Assured but average returns are expected.
Fluctuation in rainfall is experienced. Blossom showers have not performed as speculated →	Estimates indicate possibility of a below average crop in the production forecast. →	Prices are high because there is a possibility that demand will not be met. →	With high prices there is an opportunity to earn more but fluctuation in rainfall limits this possibility as yield be less. →	Though the yield is low there is a possibility that grower will be able to draw average returns and not suffer loss because of increase in prices. Given that fluctuation in rainfall is minor and it is not draught like situation.

[8] Emiko Terazono (May 5, 2015), Bears Feast on Strong Coffee, *Financial Times*. http://www.ft.com/intl/cms/s/0/782a0922-f330-11e4-a979-00144feab7de.html#axzz3v7wpPC00 (1/1/2016).

The above relationship between rainfall, crop speculation, prices, actual production output and profits gives the impression of a closed self-corrective system. However, in this self-corrective system Indian coffee growers are outsiders. A Coffee Board official points this out in his response to the growers' dissatisfaction with the Coffee Board's yield forecast.

> This is an age old problem with growers. They think our production forecasts has potential to impact the market. Though India is the fifth largest producer of coffee our overall contribution to the market is very low. Our estimates have no bearing on how prices fluctuate.[9]

Coffee prices, nonetheless, do intensely relate to weather behavior, especially in major coffee producing countries such as Brazil. In a speech delivered at UPASI Annual Conference in Coonor, Tamil Nadu in 2002 the then Coffee Board Chairperson Laksmi Venaktachalam said:

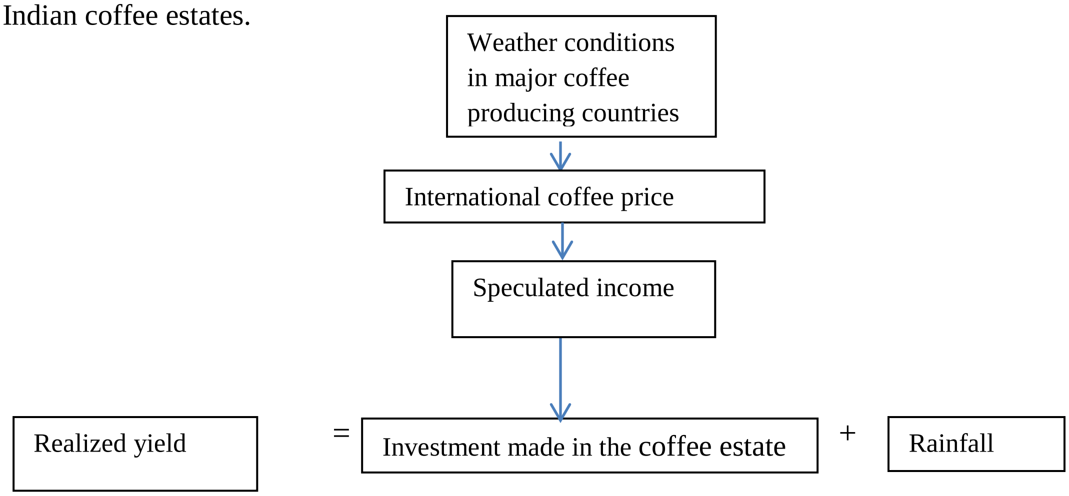
> Coffee is a commodity that goes through periodic boom and bust cycles. For the most part, these cycles have been closely associated with the Brazilian frost and its impact on world coffee production. As a result of 1994 frost, coffee prices rose to dizzy heights which enthused the growers, worldwide, to invest more in the farms aided by the fact that there were no controls over the production due to the absence of any export quotas under the ICO agreements since 1989 followed by the successive liberalization of the coffee sector which occurred across several countries and, not in the least, India. In the current crisis also, there has been intense speculation on the occurrence of the Brazilian frost usually in the months between June and August, hoping that its occurrence will dramatically improve the

[9] Excerpt from interview conducted during third round of field work.

market prices. Indeed the brief surge of coffee prices in July this year was due to cold weather conditions in Minas Gerias.[10]

Indian coffee growers' situation is better explained through the following diagram. In South India, the coffee growers case for the realized coffee yield is mostly treated as being a function of the investment made in the estate and the performance of local weather conditions. The investments made, in turn, strongly correlates with speculated income returns, which is usually informed by international coffee prices. International coffee prices as already pointed out strongly depend on weather conditions, especially of major coffee producing countries like Brazil.

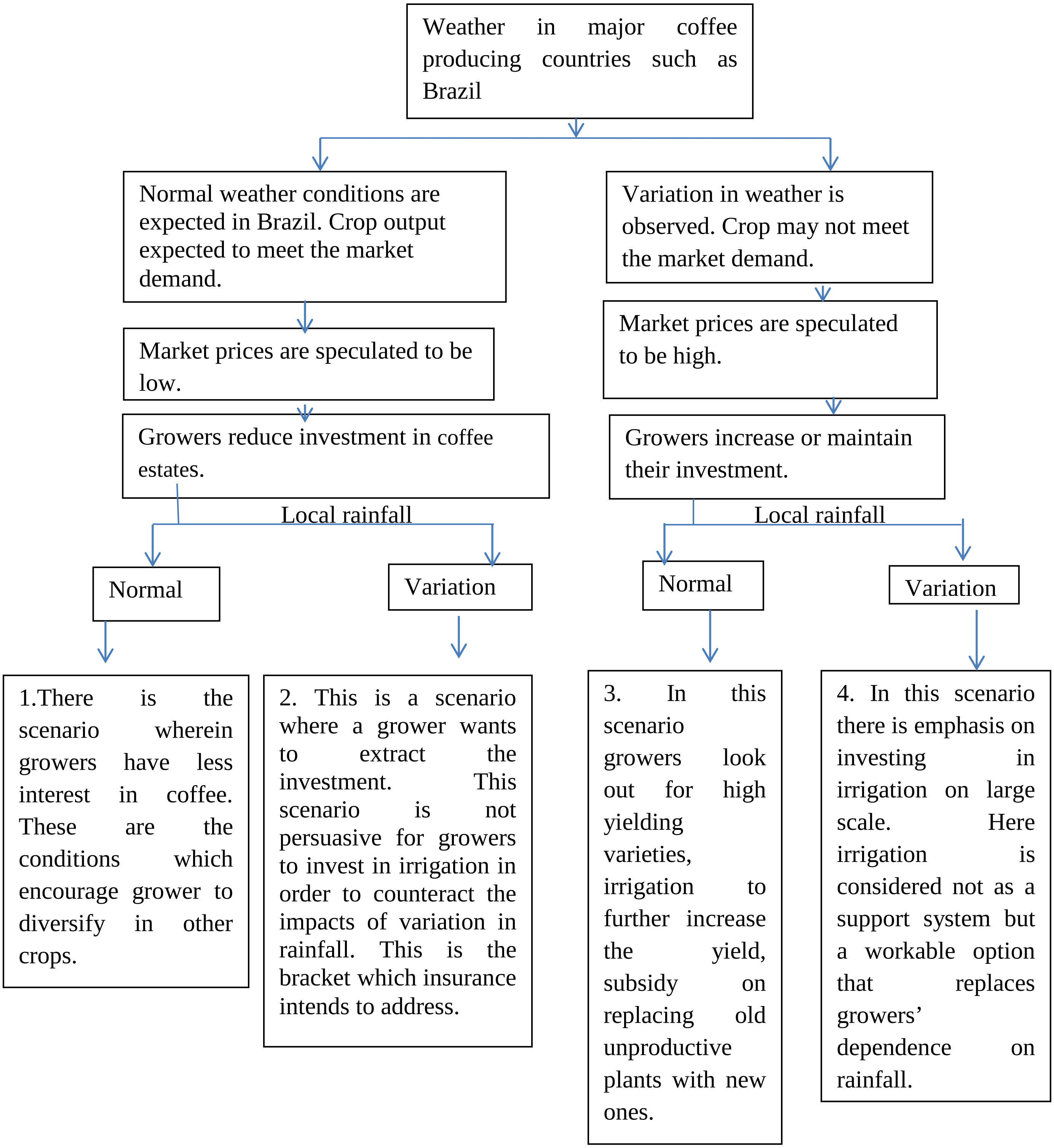
Figure 7: Flow chart showing how variation in price and rainfall affect realized yield in South Indian coffee estates.



Upon applying this framework on the ground four possible scenarios emerge.

[10] Excerpt from the speech delivered by Ms. Laxmi Venktachalam at the UPASI annual conference in Coonoor on September 2, 2002. Speech published in Indian Coffee , October 2002, LXVI (10): 3.

Figure 8: shows a detailed diagrammatic representation of four scenarios emerging from the above mentioned framework



Scenario 1: Weather conditions in major coffee producing countries are normal. A good crop is expected and international prices are, thus, low. Low prices lead Indian growers to curb their investments in the estate. Local rainfall delivers as per growers' expectation. In such a scenario growers are less interested in coffee. These are conditions where growers diversify in other crops.

Scenario 2: Weather conditions in major coffee producing countries are normal therefore international coffee prices are low. Local rainfalls, however, have not done well. In this scenario low prices dissuade growers from investing in measures that could help them salvage their crop. This scenario is most suitable for insurance.

Scenario 3: Weather conditions in major coffee producing countries show variation as a result international coffee prices are high. Additionally, local rainfalls have done well. In this scenario growers look out for high yielding varieties and other technologies to increase the yield in order to draw maximum benefit from high prices.

Scenario 4: Weather conditions in major coffee producing countries show variation as a result prices are high. However, local rainfalls have not done well. Here growers would invest in irrigation in order to increase their yield and draw benefit from the high prices.

The four scenarios can be represented in the form of following brief equations.

Scenario 1: Low prices resulting in less investment + normal local rainfall = Average to low yield

Scenario 2: Low prices resulting in less investment + variation in local rainfall= Very low yield

Scenario 3: High prices resulting in good investment + normal local rainfall = High yield

Scenario 4: High prices resulting in good investment + variation in local rainfall= Average to high yield

Growers concern about the total yield is thus seen to be emerging mainly from two sources: a) rainfall and b) financial investment. To sum up, these four equations can be perhaps distilled into a single equation: Investment + rainfall = yield

Investing in RISC to insure rainfall

An article in the February 2003 issue of *Indian Coffee* talks about the need for growers to consider insuring for what is termed as a non-traditional risk: weather risk. In this article the author, Dr. S. Radhakrishnan, flags the possibility that though coffee growers world over can take the advantage of exchange traded derivatives to insure a certain price level, in the case of the Indian grower, however, direct access to such markets is limited. The article then rounds off the observations by urging for the introduction in India for an Index Based Weather Insurance (IBWI) for coffee growers. The article argues that the IBWI could ensure that 'unpredictable risks no longer meant unmanageable risk'. [11] Anbarasu, Chief Manager of the Agriculture Insurance Company Regional Head Office in Bengaluru, in his interview with me spoke in detail about what comprised the prerequisite conditions for introducing the IBWI scheme for any crop in India:

> The development of Index Based Weather Insurance Scheme requires extensive weather and yield data. When the data reflects strong co-relation between weather events and crop yields, an opportunity exists for insurance coverage. Given that the loss events are sufficiently infrequent to permit an adequate long term return to the insurer.[12]

Building on the above understanding, it can be argued that there are two primary requirements for an IBWI scheme to deliver positive results: a) there has to be a direct

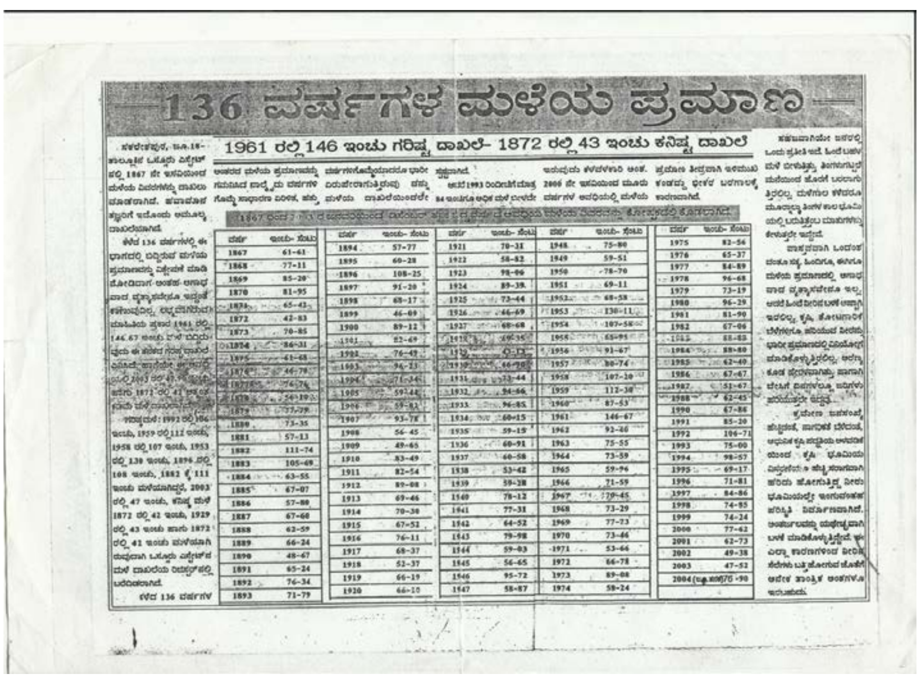
[11] Dr. S. Radhakrishnan (February 2002). Covering Non- Traditional Risks: Can weather risk be measured?. *Indian Coffee*, LXVII (2):12.

[12] C. Anbarasu interviewed at his AIC office in Bengaluru on 18/2/15.

co-relation between weather events and the crop yield and b) these weather events should be sufficiently infrequent. In the case of coffee the data thus needed would be that of rainfall and coffee yield. Looking at the scenarios outline in figure 8, it is possible, I suggest, to draw a meaningful correlation between rainfall and yield. As I point out, in three out of the four scenarios, the coffee yield reacts directly to rainfall behavior. Moreover, the conditions of complete failure of rainfall for two to three years in a row, which might result in drought condition, was considered to be sufficiently infrequent.

Raje Gowda from Arehalli in Hassan district mentioned that rainfall tends to go through a 20 year cycle in this region. As a child he remembered his father managing through a difficult drought period during the mid-1960s. He remembered struggling through a difficult period himself as a young man during mid-1980s before being devastated by the crippling 2002-2005 drought.

Picture 31 : Newspaper article showing 100years rainfall record of Ussor estate in Sakleshpura. The article was published in 2005 to argue that variation in rainfall has been happening in previous years as well. The article intends to encourage growers to continue planting coffee.



136 ವರ್ಷಗಳ ಮಳೆಯ ಪ್ರಮಾಣ

1961 ರಲ್ಲಿ 146 ಇಂಚು ಗರಿಷ್ಠ ದಾಖಲೆ- 1872 ರಲ್ಲಿ 43 ಇಂಚು ಕನಿಷ್ಠ ದಾಖಲೆ

ವರ್ಷ	ಇಂಚು- ಸೆಂಟು	ವರ್ಷ	ಇಂಚು- ಸೆಂಟು	ವರ್ಷ	ಇಂಚು- ಸೆಂಟು	ವರ್ಷ	ಇಂಚು- ಸೆಂಟು	ವರ್ಷ	ಇಂಚು- ಸೆಂಟು
1867	61-61	1894	57-77	1921	70-31	1948	75-80	1975	82-56
1868	77-11	1895	60-28	1922	58-82	1949	59-51	1976	65-37
1869	85-20	1896	108-25	1923	98-06	1950	78-70	1977	84-89
1870	81-95	1897	91-20	1924	89-39	1951	69-11	1978	96-68
1871	65-42	1898	68-17	1925	73-44	1952	68-58	1979	73-19
1872	42-83	1899	46-09	1926	46-69	1953	130-11	1980	96-29
1873	70-85	1900	89-12	1927	68-68	1954	107-58	1981	81-90
1874	86-31	1901	82-69	1928	69-35	1955	65-95	1982	67-06
1875	41-68	1902	76-49	1929	[illegible]	1956	91-67	1983	[illegible]
1876	46-79	1903	96-23	1930	46-90	1957	80-74	1984	88-80
1877	76-76	1904	71-34	1931	73-44	1958	107-10	1985	62-40
1878	56-19	1905	59-44	1932	94-66	1959	112-30	1986	67-67
1879	37-79	1906	59-83	1933	96-85	1960	87-53	1987	51-67
1880	73-35	1907	93-78	1934	60-15	1961	146-67	1988	62-45
1881	57-13	1908	56-45	1935	59-15	1962	92-40	1990	67-86
1882	111-74	1909	49-65	1936	60-91	1963	75-55	1991	85-20
1883	105-49	1910	83-49	1937	60-58	1964	73-59	1992	106-71
1884	63-55	1911	82-54	1938	53-42	1965	59-96	1993	75-00
1885	67-07	1912	89-08	1939	59-28	1966	71-59	1994	98-57
1886	57-80	1913	69-46	1940	78-12	1967	70-45	1995	69-17
1887	67-60	1914	70-30	1941	77-31	1968	73-29	1996	71-81
1888	62-59	1915	67-51	1942	64-52	1969	77-73	1997	84-86
1889	66-24	1916	76-11	1943	79-98	1970	73-46	1998	74-85
1890	48-67	1917	68-37	1944	59-03	1971	53-66	1999	74-24
1891	65-24	1918	52-37	1945	56-65	1972	66-78	2000	77-42
1892	76-34	1919	66-19	1946	95-72	1973	89-08	2001	62-73
1893	71-79	1920	66-10	1947	58-87	1974	58-24	2002	49-38
								2003	47-52
								2004 ([illegible])	70-90

Source: Newspaper clipping obtained during field work.

Coffee satisfy both these conditions a) there is an established correlation between variation in rainfall and coffee crop b) complete failure of rain or drought condition is sufficiently infrequent. This makes a a good space for introducing an IBWI scheme and it thus appears that the coffee estates in South Indian might be better suited for introducing the Rainfall Insurance Scheme (RISC). However the scheme has not been able to find much acceptance in the growers community rather there has been steady decline in the number of growers insured with the scheme despite providing a substantial subsidy.

Table 15: RISC data for Karnataka State.

S.No	Particulars	District	2007	2008	2009	2010	2011	2013	2014
1.	Total No. of Growers	Chikmagalur	4688	2017	1086	1166	529	32	182
		Kodagu	2754	3682	2128	3724	837	179	247
		Hassan	4844	2688	23377	2147	1332	77	119
		Total	12286	8387	5591	7037	2698	288	548
2.	Subsidy component (Rs. in lakhs)	Chikmagalur	22.91	40.89	9.11	13.01	6.19	0.34	13.25
		Kodagu	26.24	59.25	27.07	35.74	8.36	2.75	14.86
		Hassan	29.50	37.08	18.64	18.76	14.68	1.76	10.05
		Total	78.65	137.21	54.82	67.51	29.23	4.85	38.16

Source: AIC office, Bengaluru

Why is RISC not a good business decision?

RISC builds on the relation between the performance of the rainfall and the sensitivity of the coffee plant to precipitation. The performance or measurement of the rainfall is usually assessed through observational networks of rain gauges established by the KSNDMC and NCMSL and the coffee plant’s response to the different water stress conditions is assessed by the CCRI.

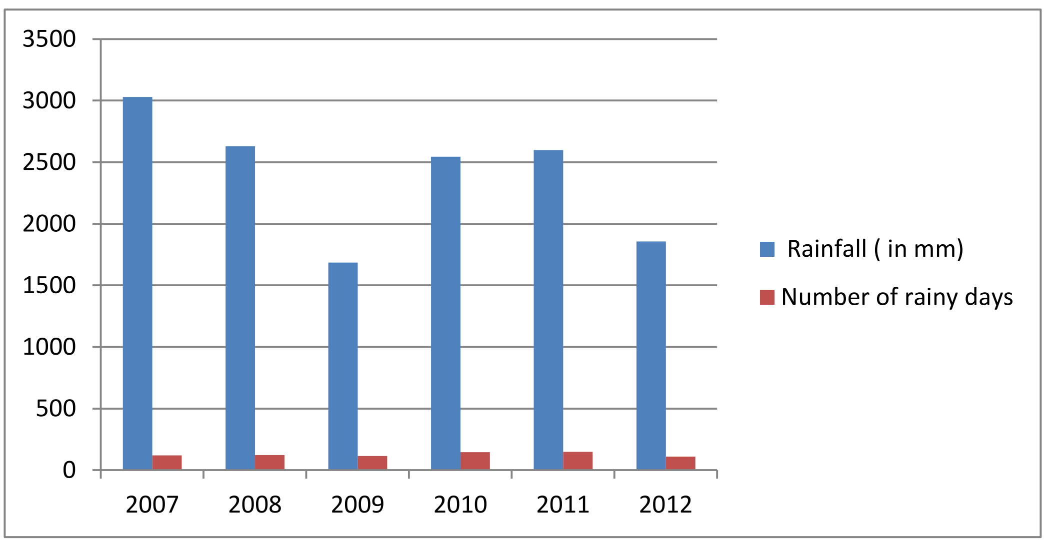
In this institutionally driven effort to address concerns emerging from variation in rainfall, precipitation data is of prime importance. Better rainfall data means better statistical surety in order to make the insurance scheme more relevant for the growers. To accomplish this KSNDMC and NCMSL have been installing an extensive network of rain gauges on the ground. But how does more detailed and extensive rain-gauge network account for scenario 1 in figure 8. A scenario in which coffee yield is low, even though the rainfall has been classed as being normal. How do we differentiate between the different extent of losses suffered because of similar kinds of variation in rainfall for instance in scenario 2 and scenario 4? This contradiction is visible on the ground. Shiela Shiv Shankar, a coffee grower in Chikmaglur, Karnataka pointed out variation in rainfall by showing a coffee tree branch which bore ripe and unripe fruits along with new and withered blossoms.

Picture 32: A branch of coffee plant bearing ripe, unripe fruits along with fresh and withered blossoms. The picture was taken at Shiela Shiv Shankar's estate, Chikmaglur in December 2011.

In order to get more growers to comment on this picture it was shown to a larger audience during presentation made at growers' workshop organized by Black Gold League (BGL) group in Mudigere, Chikmaglur on 18/1/2015. Upon sharing this picture with a larger audience of coffee grower it stood out that though this plant behavior was triggered by variation in rainfall but it was also indicative of insufficient manuring (manuring is part of investment decision).

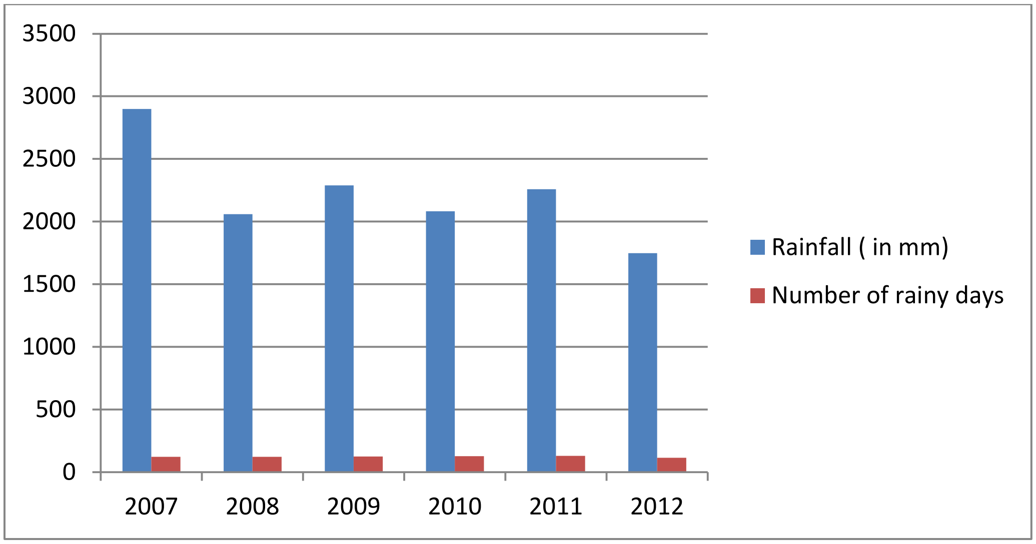
In the core equation where yield is a function of investment in the estates and local rainfall, RISC can be made to focus on the concerns emerging from variation in rainfall. However, investment in estates decides what variation in rainfall will mean to a grower. Investment can accentuate the loss as in scenario 4 or reduce the loss as in scenario 2. This is further validated from the following observation. The rainfall pattern of three coffee growing districts of Karnataka shows that Chikmaglur (mostly Arabica growing region) and Hassan (both Arabica and Robusta is grown) had relatively poor rainfall in the year 2009 which would have impacted the crop in the year 2010. Kodagu, which is essentially a Robusta growing region, however, did not show any marked variation in rainfall in that year.

Graph 5: Total rainfall (in mm) and number of rainy days in Chikmaglur district of Karnataka (2007-2012).



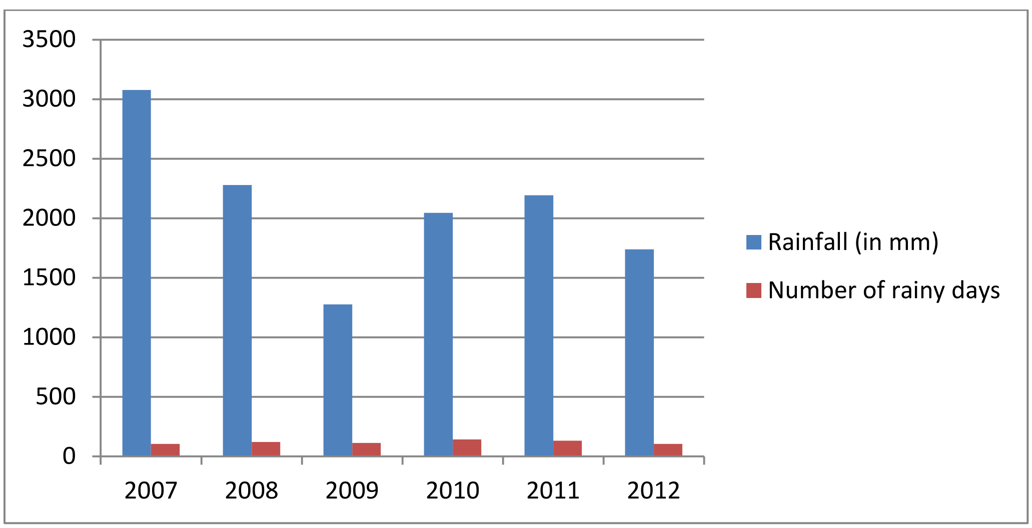
Source: *Database on coffee* (February 2016), Market Research and Intelligence Unit Coffee Board, P.97
http://www.indiacoffee.org/Database/DATABASE_Feb16_II.pdf (5/11/2016)

Graph 6: Total rainfall (in mm) and number of rainy days in Kodagu district of Karnataka (2007-2012).



Source: *Database on coffee* (February 2016), Market Research and Intelligence Unit Coffee Board, P.97
http://www.indiacoffee.org/Database/DATABASE_Feb16_II.pdf (5/11/2016)

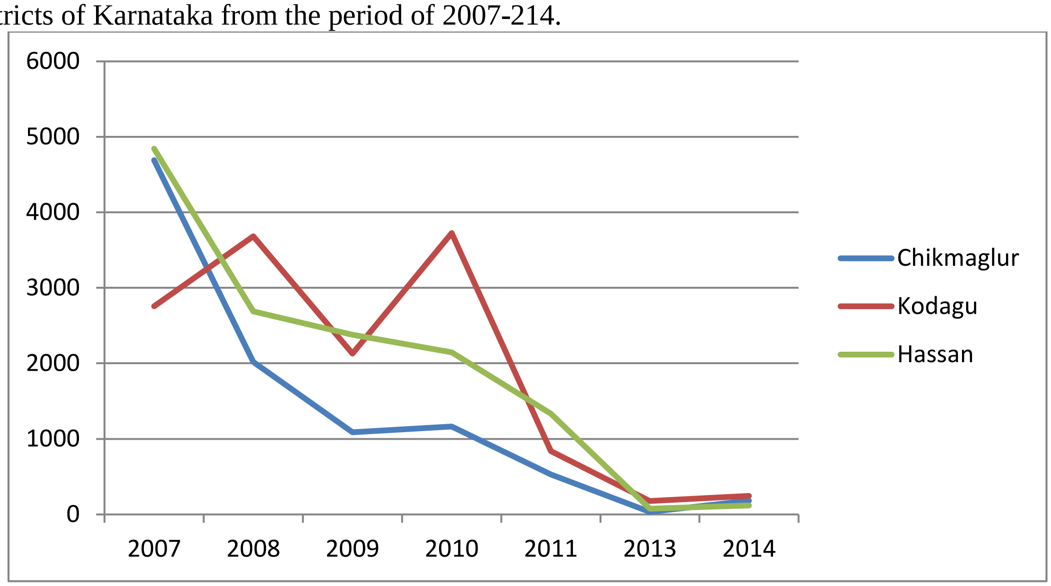
Graph 7: Total rainfall (in mm) and number of rainy days in Hassan district of Karnataka (2007-2012).



Source: *Database on coffee* (February 2016), Market Research and Intelligence Unit Coffee Board, P.97
http://www.indiacoffee.org/Database/DATABASE_Feb16_II.pdf (5/11/2016).

Going by this simple logic, the growers in areas with higher variation in rainfall should be more interested in investing in RISC. That means there should have been more RISC subscriptions from Hassan and Chikmaglur than Kodagu. However, a look at the RISC data about the actual number of growers insured in these three districts give us a surprisingly different story. Kodagu which showed least variation in rainfall for 2009 had maximum subscription of RISC, whereas Chikmaglur and Hassan which showed marked fluctuation in rainfall witnessed only a slight increase in the number of subscriptions for RISC.

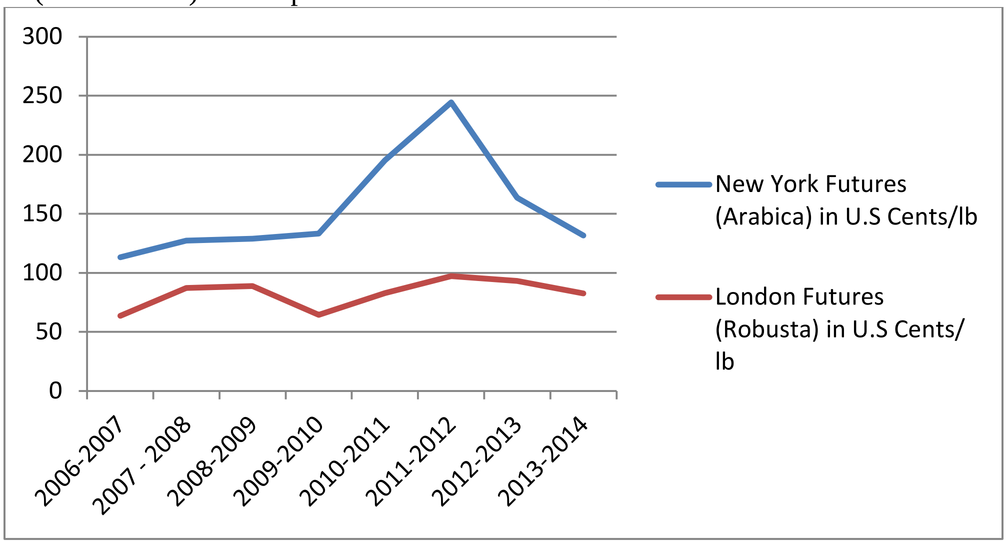
Graph 8: Number of grower Insured with RISC scheme in Hassan, Chikmaglur and Kodagu districts of Karnataka from the period of 2007-214.



Source: Based on data primary provided by AIC office Bengaluru.

This contradictory observations gathers clarity, however, only if we bring to the discussion how the variation in market prices of Arabica and Robusta was during 2007-2014 period.

Graph 9: Showing fluctuation in New York futures prices (for Arabica) and London futures prices (for Robusta) for the period between 2006-2014.



Source: *Database on coffee* (February 2016), Market Research and Intelligence Unit Coffee Board, P.92, http://www.indiacoffee.org/Database/DATABASE_Feb16_II.pdf (5/11/2016).

The graph is based on the coffee crop cycle and tells us that the Robusta prices started dipping in the year 2008-09 and were at their lowest value in 2009-10. Arabica prices, on the other hand, were starting to trend higher. While Arabica growers in Chikmaglur and Hassan found themselves in scenario 4 with sharp variations in rainfall, the Robusta growers in Kodagu found themselves in scenario 2 with only a slight variation in rainfall in 2008-09.

A good business decision, as is generally held by many growers, is one where returns are made profitable by investments. For a grower, investment decisions are mostly based on market calculations that inform the growers' speculative behavior about the likely harvest and coffee prices. This speculation exercise is also critically dependent on his/her expectations about the likely rainfall on the estate. Returns from RISC as an insurance scheme, however, are decided by the meteorological information gathered by the Reference Rain Gauge (RRG) network. While speculations about the crop output, investment in the estate and expectations from rainfall are within the growers' decision making domain, the RRGs are beyond the growers' decision making domain.

In case of RISC, therefore, the growers' returns and investments do not commensurate with each other. Rather investing in RISC commits the growers to a new source of vulnerability: the distance of his estate from the nearest RRG and how the meteorologists model rainfall expectations and how statistically patterned rainfall data establishes the growers' insurance entitlement. In effect, weather information, as assembled by a collection of scientific protocols about meteorological events and by the placement of rainfall data stations, I argue, can often be insensitive to the micro-topography within the growers' estate and therefore not correctly capture the exact impact of the rainfall in the estate. RISC, therefore, introduces a new kind of vulnerability for the grower rather than solving entirely the problem of vulnerability.

Concluding remarks

Artificial irrigation and insurance (RISC), I point out, help growers' to deal with the impacts of variation in rainfall. As argued in chapter 5, however, growers' decision making on estate for growing coffee is being increasingly informed by weather information rather than the weather event itself within their estate. This transition has had important implications on the ground, when the growers have to weave in market calculations and their speculative behavior when grappling with meteorological forecasts and the data generated by rain gauge networks. In particular, I contend that given how complex the pricing factors are for coffee production the type and nature of weather information often constrains the grower from taking his experiences and situated experience into account when making growing decisions for his/her estate.

This chapter thus argues that from a growers' perspective investing in irrigation and RISC is not a choice between less vulnerable or more vulnerable scenarios. It is rather a choice between two different kinds of vulnerabilities with regard to decision-making for growing coffee.

Chapter 8

Conclusion

This thesis documents, explores and examines three different perceptions about rainfall that inform and shape decision making possibilities for coffee growers, in their estates located in the Western Ghats belt of South India. These perceptions about rainfall, I point out, can be classed in three distinct typologies: a) the everyday experience of coffee growers; b) the scientific precipitation measurements by meteorologists and c) as statistical patterns assembled by insurers. These distinct and differing perceptions on rainfall, I then go on argue, suggest that weather events are subject to interpretation based on how knowledge and understanding are oriented. Consequently, any effort to develop credible responses to climate change impacts must be alert to how contending knowledges- especially on the ground or as we downscale towards finer resolutions- shape our understandings about weather events and their varied implications. This thesis, in essence, is aimed at uncovering a range of conceptual problems that animate discussions about contemporary climate change adaptation strategies on the ground, which are increasingly framed as tensions between global facts and situated knowledges.

Adaptation is one amongst the two strategies that are thus far available to address climate change impacts. The other strategy being mitigation. Mitigation refers to efforts aimed at reducing or preventing greenhouse gas emissions (GHGs), while adaptation refers to the adjustments that societies make to limit the negative impacts or to take advantage of opportunities provided by a changing climate. For a considerable period, nonetheless, in climate change discussions, the idea of adaptation was often viewed as simply being a poor cousin to the more urgent interventions required for mitigation strategies.[1,2,3] Having been thus framed, under the shadow of mitigation, there was a

[1] Roger Pielke Jr., Gwyn Prins., et.al. (2007). Lifting the Taboo on Adaptation. *Nature* 445: 597-598.

tendency in the earlier years to limit the idea of adaptation to merely addressing the impacts from localized weather events.[4]

Increasingly, however, in recent years, a sense of urgency, purpose and deliberateness is being attached, especially at the policy level, to the many possibilities that adaptation holds for responding to climate change challenges. As pointed out in the earlier chapters, many of these expectations sit uneasily with existing conceptualization of climate change adaptation, essentially as problems of the 'global gaze'. In effect, formulating credible climate change adaptation strategies requires us to understand the challenge of situated knowledge and it is towards unravelling the impacts of the weather event at the local level that this thesis explores a range of conflicting and often times overlapping perceptions about rainfall.

My field studies for this thesis was carried out in the coffee growing belt of South India. Most coffee estates are located in the three South Indian states of Karnataka, Tamil Nadu and Kerala. They are located in the Western Ghats belt which is amongst the eight biodiversity hotspots in the world. Much of the coffee growing in this region is characterized by shade. Shade traditionally refers to the original tree cover that is indigenous to the Western Ghats ecology. The coffee estates in this space thus require active engagement and continuous negotiations between coffee growers and their local ecological conditions.

The coffee estates are located in the Malnad region in the Western Ghats belt. Malnad mainly receives the South –West monsoon and covers large portions of the six districts in the South Indian state of Karnataka. The coffee estates visited for this study

[2] Robert G Biesbroek et.al. (2009). The Mitigation-Adaptation Dichotomy and the Role of Spatial Planning. *Habitat International* (33): 230-237.

[3] Jon Barnett. (2001). Adapting to Climate Change in Pacific Island Countries: The problems of uncertainty. *World Development* (29): 977-93.

[4] Lesley Head. (2010). Cultural ecology: adaptation-retrofitting a concept? *Progress in Human Geography* 34(2): 234-242.

are found in three of the six districts: Kodagu, Chikmaglur and Hassan. Additionally I also visited estates in the Palini hills in Dindigul district, Tamil Nadu. Palini hills are located in the eastward extension of the Western Ghats.

While concerns about weather, especially rainfall, were part of everyday decision making at the coffee estate, the discussions about climate change seemed to require an altogether different template for assessment and comprehension. These distinct frameworks for judging and reacting to climate change impacts and weather variation, in fact, as I pointed out, resonate with the STS scholar Sheila Jasanoff's claim that the 'spatial and temporal scales' at which the climate change narrative are comprehended often cuts against the grain of common human experience. She suggests that there is an urgency in calling for a rethink over the politics of the representations of climate change by going beyond the impersonal scientific framings and instead committing the discourse to be 'synchronized with the rhythms of everyday life.'[5]

The effort of this thesis was to take up Jasanoff's insight by aiming to understand how climate change impacts are understood and played out in local contexts. The term situated knowledge is most associated with feminist geographers and their critiques of the process of knowledge production. Drawing inspiration from the works of Donna Haraway, who commented critically on the construction of scientific knowledge, feminists have challenged the truth claims of detached disembodied means of knowing the world. By situated knowledge, Haraway argues that knowledge can be partial, located, and embodied: that is, knowledge always comes from someone somewhere.[6]

For this study, the concept of situated knowledge perhaps best captures the complexity with regard to how rainfall as a weather event is understood by a range of actors and institutions in a social context. I argues that knowledge is contextually generated and simultaneously embodies understandings of both the natural and social

[5] Sheila Jasanoff. (2010). A New Climate for Society. *Theory, Culture & Society* 27(2-3):236

[6] Warf, B. (Ed.). (2006). *Encyclopedia of Human Geography*. Sage Publications.p.430.

worlds. In this, of course, popular understandings in many instances may not necessarily be so different from scientifically validated knowledge. Situated knowledge does not aim at romanticizing ‘other forms’ of knowledges nor does it entirely questions the legitimacy of science. It gives agency to both the observer and the object of study. It focuses on connections and interconnections. While trying to address this objective of the study the larger canvas of research questions fit into following three points:

- How is the understanding of a weather event experienced in a situated context?
- How are climate change impacts as global facts conceptually different from weather variation at the local level?
- How to formulate climate change adaptation strategies when local values afford different weather experiences than the statistically patterned and scientifically measured data.

After introducing the argument (Chapter 1), laying out the conceptual framework (chapter 2) and delineating the approach to the field (chapter 3), the thesis moves to chapter 4 to explore how the notion of rainfall, at the local level, is grasped in three distinct and yet at times overlapping perceptions. Once again, to reiterate, these three perceptions are a) growers’ experience of rainfall b) meteorologists’ scientific measurement of precipitation and c) the insurers’ statistical data.

Chapter 4, argues that for coffee growers the perception of ‘normal’ rainfall draws from the unique topographical, ecological and climatic understanding afforded to them by the location of the plantation. For insurers, on the other hand, normal rainfall is a statistical function of the estates’ location in a geographic grid and defined by its quantitative yield. The correlation between yield data and rainfall data defines ‘normal’ rainfall for the insurers. For meteorologists, however, ‘normal’ rainfall is the arithmetic average of rainfall over a 30 year period. Put simply, for the meteorologists normal rainfall is a function of a time frame rather than a geographic or locational specificity.

Chapter 4 then moves on to highlight incidences of variations reported by growers which are not reflected in scientific and statistical perception of rainfall gathered by meteorologists and insurers. The chapter thus argues that these different perceptions do not always meaningfully converge on the ground and the incidences highlighted by growers are indicative of such conceptual dissonances and disagreements.

The next chapter 5 explores what happens when these different perceptions are brought into contention in the form of adaptation strategies which are informed by meteorological information of rainfall to address growers concerns. Chapter 5 discusses how the growers' decision-making efforts to adapt their coffee cultivation practices to contend with sharp rainfall variation requires them to invest in two broad strategies: a) irrigation and b) insurance. While irrigation requires a credible rainfall forecasts for decision making, on the other hand, evolving an insurance template requires rainfall data to be grasped as a statistical pattern. Here, I argue that the growers' vulnerability ─ in terms of returns on investment for implementing in these strategies ─ becomes a function of meteorological information about the weather event rather than the weather event itself. Meteorological information which is relatively blind to geographical, locational and micro-climatic sensitivity contrasts uneasily with growers situated experience with rainfall impacts that are based on the estate's unique topographical and ecological contexts.

The next chapter 6 unpacks the meteorological exercise in formulating the rainfall forecast. The chapter points out the difference between what constitutes a useful forecast and a meteorologically successful forecast. Chapter 6 shows that the exercise of producing meteorologically successful rainfall forecast involves three steps. These are: a) using weather models to produce forecast at different spatial and temporal scales; b) gathering ground observations through telemetric rain gauge network and satellite images; and c) statistical tools to compare the model output and ground observations. For a forecast to be meteorologically accurate it has to follow certain standardized protocols. But for a rainfall forecast to be useful in such a context, I argue, it has to nonetheless address or rather be translated for situated concerns. Growers pick and choose the source of information depending on their specific requirement. For the grower, the success of the forecast depends greatly on his/her ability to exercise a degree of autonomy with regard to acting on his/her interpretation of the weather event.

Meteorologists on the other hand understand a forecast though formal, institutional and structured protocols for perceiving rainfall as a precipitation event in terms of absolute quantitative numbers. For them, the success of a forecast depends on the performance of certain statistical tools. I point out, in particular, how several types of conceptual mismatches occurs when the meteorologists' perceptions fails to accommodate the unique environmental conditions prevailing in a coffee grower's estate.

Chapter 7 explores the relationships between the impact of the variation in rainfall and the preparedness of the grower based on his/her market speculations. This chapter shows that the impact of rainfall on a coffee crop is often directly related to the nature and type of investments made by the grower for cultivating coffee. Investments refer to fertilizers, manures and other inputs that are added to improve and grow the crop. Investment is a financial decision driven and shaped by various market speculations that a grower makes in order to generate economic returns. These financial speculations, moreover, try to harness presumed market price movements. Based on the investment made and the performance of the rainfall, this chapter identifies and discusses four impact scenarios in which a grower might find himself/herself. The chapter shows that impact scenarios are put together in the main by two components: a) performance of the rainfall and b) growers investment decision. In particular, I contend that given how complex the pricing factors are for coffee production the type and nature of weather information often constrains the grower to the point of compelling him/her to ignore the experiences and situated knowledges when making growing decisions for his/her estate. This chapter thus argues that from a growers' perspective it is not a choice between less vulnerable or more vulnerable scenarios but rather responding to meteorological information has thus become a choice between two different kinds of vulnerabilities with regard to decision-making for growing coffee.

How this research contributes to advancing knowledge in STS

Different perceptions of weather are pursued on the ground and this thesis argues that the challenge for adaptation strategies is to understand how these differing perceptions interact and inform each other. In the coffee estates, located in the Western Ghats belt of South India, these different perceptions of rainfall, I argue, have the potential to increasingly go out of sync with each other. The challenge for adaptation strategies for coffee growers is to acknowledge this gap and engage with them.

Discussing climate change impacts in terms of its implications within particular situated contexts helps us grasp one of the distinguishing features of climate change from other environmental problems. The 'climate' in climate change, as Hashtrup informs us, emerges from the unique entanglements of natural and social processes.[7] Different knowledges about the weather event in particular becomes one of the active and critical sites for these entanglements between the 'natural' and the 'social'. Reconsidering climate change adaptation from an STS perspective, I argue, needs us to engage with different kinds of knowledges that can span the range from individual experience to one based on strict scientific and technical protocols. The knowledge or the site of entanglement between the 'natural' and 'social' is thus where the meanings about a weather event can be generated. In other words, as I have sought to argue in my study, these meanings about the weather event could and often did drive decision-making for coffee growers.

In sum, this thesis is intended to underline the need for ethnographic studies to explain how climate change adaptation strategies on the ground can draw from insights in Science Technology Studies. The value of STS, I suggest, helps provide us a

[7] Kristen Hashtrup.(2013). Anticipating Nature.*The Social Life of Climate Change Models* (eds.) Kristen Hashtrup and Martin Skrydstrup. Taylor and Francis. p.2

conceptual toolkit which can be used to understand complex environmental problems which require not romanticizing alternative forms of knowledge[8] while simultaneously not arguing for science as being the only means for understanding the physical world. It suggests that in climate change studies people's situated experience of weather represents more than a secondary 'nonfactual' data set. The notion that groups of citizens may bring relevant forms of knowledge and expertise to scientific processes has, in facts, been widely discussed in STS studies.[9,10,11]

It is in response to these challenges that STS scholars are increasingly contributing to what we now describe as interactions between climate, weather and society.[12] However, from a social and policy point of view, it makes sense to speak of the weather- climate continuum, in which global facts and local values need to be drawn ever so closer into a helpful dialogue.

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Coffee Glossary

Anthesis: The flowering period of the plant starting from opening of the flower bud.

Backing showers: Rains received in the month of May.

Blossom shower: Rains received in the month of March and April for Robusta and Arabica respectively. Commonly known as *Revathi Malay*.

Berry: coffee fruit is called berry. It is small, pulpy and has seeds.

Cherry: It is the dried coffee fruit. It is obtained through dry method of post-harvest processing. In dry processing method all harvested fruits are subject to drying at a flat surface known as drying yard.

Cropping wood: The fruit bearing nodes on the branch of coffee plant.

Dry method: It is post-harvest processing method. In this method the harvested fruits are dried on the drying yard. Through this process cherry is obtained.

Fruit set: It is the process that follows pollination and fertilization in coffee flower. From the stage of fruit set to ripening of coffee fruit takes 5 months.

Pinking & Paddying: It is an abnormal floral condition which occurs when the coffee plant is under stress. Stress conditions occur due to low humidity after flowering, prolonged high temperature and low rainfall.

Perennial plant: A plant that lives over many years. Coffee is a perennial plant with annual bearing habit. That means it bears flowers and fruits once every year.

Pollination, **Cross-pollination, Self-pollination**: pollination is the process of transferring pollens from the male anther of the flower to the female stigma. When pollen are delivered from the stamen of a flower to the stigma of a flower on another plant of the same specie it is called cross pollination. When pollination happens between pollens and stigma of the same flower or flowers on the same plant it is called self-pollination. Arabica is self-pollinated whereas Robusta is cross-pollinated.

Ripening: It is the final stage in the process of coffee fruit development. It is the stage at which fruit attains maturity and becomes palatable. A ripened coffee fruit is dark maroon to violet in color.

Wet method: It is post-harvest processing method. In this method harvested coffee fruits are washed to remove skin and mucilage. The washed seeds are then dried in the sun.

ANNEXURES

Annexure 1

References and Data Sources from the Field

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Extension folder published by Central Coffee Research Institute (CCRI), Coffee Board.

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2. Diseases of coffee: Trunk Canker, Extension folder No. 19/2009.

3. Diseases of coffee: Root diseases, Extension folder No.20/2009.
4. Coffee varieties from CCRI: Arabica, Extension folder No. 1/2012.
5. Coffee varieties from CCRI: Robusta, Extension folder No. 2/2012.
6. Vegetative propagation in coffee, Extension folder No. 3/2012.
7. Plant training and pruning in coffee, Extension folder No. 5/2012.
8. Sprinkler irrigation in coffee, Extension folder No. 6/2012.
9. Know how about organic coffee certification, Extension folder No. 7/2012.
10. Pests of coffee: Mealybug, Green scale and Brown scale, Extension folder No. 15/2012.
11. Pests of coffee: Nematode, Extension folder No. 16/2012.
12. Diseases of coffee: Leaf Rust, Extension folder No.17/2012.
13. Diseases of coffee: Black Rot, Extension folder No. 18/2012.

Extension folders in Kannada

1. Extension folder No.1/2011.
2. Extension folder No.4/2011.
3. Extension folder No.5/2011.
4. Extension folder No.8/2011.
5. Extension folder No.9/2011.
6. Extension folder No.10/2011.
7. Extension folder No.12/2011.

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Annexure 2

List of interviews

First round of field work: November, December 2011

Details of the coffee growers' interviewed

S.no	Name	Estate address	Interview Details (Date/ place/ time)	Contact Details	His/her contact was obtained through
1.	H.R.Basanna	Anne Mahal Village, Sakleshpura Taluq, Hassan District, Karnataka	21/11/2011, at his residence, 1 hour	09141760389 basannahr@gmail.com	Viva Kermani of CSM.
2.	M.A. Girish	Magehalli Gendehalli Post Belur Taluq Hassan district, Karnataka	22/11/201, HDPA Office, 1 hour.	09449206371	Dr. Pradeep (President KGF)
3.	Patel.H.R. Prasad	Anupama Estate Halasuge Post Sakleshpura Taluq Hassan District , Karnataka	22 /11/2011, at his estate, 1hr 15 mins.	08173-230150	M.A. Girish
4.	M.V. Nandan	Nandan Estate Halasuge Post Sakleshpura Taluk Hassan District, Karnataka	22 /11/2011, at his estate, 1hour.		Girish
5.	Sanjay	Vasantkool Estate Ankithalli Belur Taluq, Karnataka	23/11/2011, at Planters Club, Sakleshpura, 30 minutes.	08177-264430	Met at Planters Club
6.	Prasanna M	Magadi Mane Halasulige Post Sakleshpura, Karnataka.	26/11/2011, at his estate, 1hour and 30 minutes.	09482724242	Girish
7.	Dr. Anand T. Pereira	Joe's Sustainable Farm Kirehully Estate Sundekere Post Sakleshpura Taluk	29/11/11, at his estate,2 hours and 20 minutes	08173-329231	Pushpnath Krishnamurthy

		Hassan District, Karnataka.			
8.	N.S.Somshe khar	Orange valley Estate Kyamanahally Village and Post Hanbal Hobli Sakleshpura Taluk Hassan District, Karnataka.	1/12/11,at his estate.45 minutes		Niranjan (I stayed with Niranjan's Family)
9.	Raja Ram Alva, Manager, ABC Plantation	ABC Plantation Kyamanahally Village and Post Hanbal Hobli Sakleshpura Taluk Hassan District, Karnataka.	1/12/11, at the plantation office ,45 minutes	09448194065 rajaramalva@indiatimes.com	N.S. Somshekhar
10.	Peter Mathias	Kelagur Estate Javali Post Chikmaglur District, Karnataka.	2/12/11, kelagur estate, 3 hours	09448971433 pgmathias@yahoo.co.in	Aparna Dutta
11.	H.M. Mahendra	Hanbel Estate Hanbel Village and post Sakleshpura, Hassan, Karnataka.	4/12/2011, Hanbel estate, 1 hour 50 minutes.	09448920231	Vatsalya (H.M. Mahendra's wife)
12.	H.M.Madan	Hanbel Estate Hanbel Village and post Sakleshpura, Hassan, Karnataka.	4/12/2011, Hanbel estate, 1 hour.		H.M. Mahendra
13.	Kuldeep Jayaprakash	Kukkan Kumbari Estate Hanbal Village &Post Sakleshpura, Hassan, Karnataka.	4/12/11, at his home in Hanbel, 35 minutes.	09880007079	H.M.Mahendra
14.	H. B. Bhaskar	Amurathshwara estate Hanbal Village and Post Sakleshpura, Hassan, Karnataka.	4/12/11, at his house in Hanbel, 30 minutes.	09448920205 hanbalbhaskar@gmail.com	H.M.Mahendra
15.	Geetha Suresh	Jaladarshini estate Bykere Post Sakeleshpura, Hassan, Karnataka.	5/12/11, at her home in Bykere, 2 hours.	09008870209	Vatsalya
16.	Fatima w/o Sayed Ali	Bykere village Sakleshpura,, Hassan, Karnataka.	6/12/11, at Geetha's house, 30	09242647186	Geetha Suresh

			minutes.		
17.	Shivaana	Bykere village, Sakleshpura,, Hassan, Karnataka.	6/12/11, at Geetha's house in Bykere, 25 minutes	9449180325	Geetha Suresh
18.	Gokula	Nagra village Bykere (post office), Sakleshpura, Hassan, Karnataka.	6/12/11, at his plantation, 30 minutes.	9449207217	Geetha Suresh
19.	Nawab	Nagra village Bykere (post office), Sakleshpura, Hassan, Karnataka.	6/12/11, at his plantation, 30 minutes.		Gokula
20.	Abdul Sattar	Nagra village Bykere (post office), Sakleshpura, Hassan, Karnataka.	6/12/11, at his plantation, 30 minutes.		Gokula
21.	Hafizaunnis a	Nagra village Bykere (post office), Sakleshpura, Hassan, Karnataka.	6/12/11, at his plantation, 30 minutes.		Gokula
22.	Nanje gowda	Nagra village Bykere (post office), Sakleshpura, Hassan, Karnataka.	6/12/11, at his plantation, 1 hour.		Geetha Suresh
23.	A Viswanath (ex-manager Tata coffee estate)	Swarna Cool Estate Sathigal Sakleshpura, Hassan, Karnataka.	7/12/11,at his home, laxmipuram, Sakleshpura, 50 minutes	09448129723	Sumathi and Vatsalya (WCPC)
24.	Shiela Shiv Shankar	Belagola Estate Bogase Post Chikmaglur Taluk, Near Bhadra forest Chiklmaglur district: 577130, Karnataka.	10/12/1, at her Plantation, 2 hours .		Niranjan
25.	Ravi Shankar Belagola	-do-	10/12/11, at his home in his estate,50 minutes		Niranjan
26.	T.D.Rajego	Bassapura Plantation	10/12/11, at		Ravi

	wda	Kadapanthi Post Via Sangmeshwar Pet Chikmaglur Taluk Chikmaglur District : 577136, Karnataka.	his home in his estate, 1 hour.		Shankar Belagola
27.	B.M. Bojagowda	Avikibhan estate Bassapura Village Kadapanthi Post Via Sangmeshwar Pet Chikmaglur, Karnataka.	10/12/1, at T.D.Rajegowda's House, 50 minutes		T.D. Rajegowda
28.	Shiv Shankar (Shiela Shiv Shankar's husband)	-do-	11/12/11, at his home in his estate,50 minutes		Niranjan
29.	Swarup Vikram	Vikram Plantation Kadavanthi Post Chikmaglur Taluk Chikmaglur District- 577136, Karnataka.	11/12/11, at his house, 1 hour 15 minutes.	09449728056	Shiv Shankar
30.	B.G.Mahendra	Kirogolli Estate Kadavanthi Post Via Sangmeshwar Pet Chikmaglur taluk Chikmaglur District- 577136, Karnataka.	11/12/11, at Swarup Vikram's House, 1 hour and 15 minutes.	09448997570	Vikram Swarup
31.	Adarsh Basavraj	Shri Nandi Estate Sakleshpura, Hassan Karnataka.	12/12/11, Luxmipuram, Sakleshpura, 1hour 15 minutes	0974309566	Sumathi from WCPC
32.	Basavraj (Adarsh's father)	Shri Nandi Estate Sakleshpura, Hassan Karnataka.	12/12/11, Luxmipuram, Sakleshpura, 1hour 15 minutes		Sumathi from WCPC
33.	Dr. Pradeep N.K	Shri nandi Estate Chakanhalli Post Belur Hassan, Karnataka.	19/12/11, KGF office, Sakleshpura, 1 hour 15 minutes.	09448106275 pradeep_nandi @yahoo.com	Viva Kermani

34.	B.M. Jagnath	Sri Nanjundeshwara Estate Balllupet Hassan, Karnataka.	19/12/11, at his estate, 3 hours.	09448047844 Jagannath.ba@gmail.com	Dr. Pradeep N.K
35.	D.S.Raghu Ex Chairman Indian Coffee Marketing Cooperative (CoMARK)	Dundiga estate Halase Post Mudigere- 577132 Chikmaglur, Karnataka.	20/12/11, at his estate, 1 hour 30 minutes	09448665374 08263220233 dsraghu1957@dundiga.com	Dr. Pradeep N.K
36.	D.B. Subbe Gowda Chairman (CoMark)	-do-	20/12/11, at his estate. He is D.S.Raghu's Father,1 hour.	09448530235	Dr. Pradeep N.K
37.	Gangehegde	Chetanhalli Estate Chakanhalli Post Belur, Hassan, Karnataka.	20/12/11, at his estate,1 hour		Dr. Pradeep N.K
38.	Raje Gowda	Arrehalli Belur, Hassan, Karnataka.	21/12/11, at Arrehalli Planters Association office, 2 hours	09242103769	Viva Kermani
39.	P.Vishvanathan Nayak	Pavanaganga Estate Garje road Arehalli Belur, Hassan, Karnataka.	21/12/11, at Arrehalli Planters Association office, 15 minutes.	09663880440	Raje Gowda of Arrehalli
40.	M. Ataur Rahman	Adganchnally Estate Arehalli : 573101 Belur, Hassan, Karnataka.	21 /12/11, at His estate, 45 minutes.	09980435837 08177221443	-do-
41.	F.R. Abid S/o Late Abdul Bashid	Tahir Nest Temple street Arrehalli, Belur, Hassan, Karnataka.	21 /12/11, at Arrehalli Planters Association office, 30 minutes.	09141722121	-do-
42.	Mohd.	S/o Mohd. Ghouse	21/12/11, at	09900376431	-do-

	Shafee	Armaan Estate Arrehalli, Belur, Hassan, Karnataka.	Arrehalli Planters Association office, 30 minutes.		
43.	B.I.Khaleel Mahmood	Near Gurgulli Estate A.T.Road Arrehalli, Belur, Hassan, Karnataka.	21/12/11, at Arrehalli Planters Association office, 30 minutes.	09141272967 08177221784	-do-
44.	Vijendra Prasad	Ballupet- 573214, Sakleshpur, Hassan, Karnataka.	22/12/11, at Ballupet Planters Association office, 20 minutes.	09341060471	B.M. Jaganath
45.	Manjunath	Rudraprayag estate Ballupet Sakleshpura, Hassan, Karnataka.	22/12/11, at his estate, 30 minutes.	09448529723	-do-
46.	S.M.Somes h	Sidigalale Village Moogli Post office Sakleshpura, Hassan, Karnataka.	22/12/11, at Ballupet Planters Association office, 20 minutes.	09448448705	-do-
47.	H.D. Bopaiah	Ambukote estate Devarapora Post Via Gonakopal South Coorg: 571213, Karnataka.	24/12/11, at his home in Gonikopal, 2 hours.	08274247046	Niranjan
48.	Tej Thimaya	Nelikad Estate Polibata Post, South Coorg- 571215, Karnataka.	24/12/11,at his estate in Kodagu, 2 hour.	09448051004 tejt@rediffmail .com	Reshma (H.D. Bopaiah's wife)

Other interviews carried out during first round of field work

S.no	Name	Association with coffee	Interview details	Contact details	His/ her contact was obtained through
1.	Keshav Dev	Owner of Devan's Coffee Shop.	25/8/11,131, Khanna Market, Lodhi Colony New Delhi, 20 minutes	9810775464 devkeshav@hotmail.com	Dr. Rohan D'Souza
2.	Sunalini Menon	Worked with coffee board as Director quality control till 1995. Now she is running a coffee consultancy firm, in Bangalore: Coffee lab She is the first women coffee taster of Asia	11/11/11, # 471, 10th main, Raj Mahal Villa, Extension, Banglore, 50 minutes	coffeelab@vsnl.com	Internet
3.	Aparna Dutta	She has worked with India coffee magazine as a guest editor. She has written extensively on coffee. Her work is available in the form of books, articles and memoirs in Coffee Board Library. At present she is working at IIM Bangalore.	14/11/11, in her office at IIM Banglore, Banergatta Road, 1 hour	penscape@rediffmail.com	Internet

4.	Viva Kermani	She is chief operating officer at Centre for Social Markets, a non profit organization. CSM is closely working with Karnataka Growers Federation.	Many meetings at their office		
5.	Pushpnath Krishnamurthy	He works with OXFAM , UK. At present he is engaged in an externship programme with CSM. He has been working with planters from Hassan district, Karnataka for more then 8 years.			
6.	Prof. Govindswami Bala	Associate Professor Center for Atmospheric and Oceanic Science Indian Institute of Science Bangalore - 560 012,	14/11/11, at his office in IISc, 30 minutes	gbala@caos.iisc.ernet.in	Internet
7.	Achaiah M.Kariappa	Managing director, MudreMane Coffee Curers, K.M. Road, Mudigere, Chikmaglur.	2/12/11, at his office, 20 minutes	achaiah@mudremane.com	Niranjan
8.	T.M. Shivappa	Farm incharge, Coffee Demonstration Farm Mutsagar, Sakleshpura.	7/12/11, Mutsagar Sakleshpura, 45 minutes.		Direct inqury at Coffee Demonstration Farm.
9.	Dr. Maria Violet D'souza	Divisional Head, Agricultural Chemistry, Central Coffee Research Institute, Balehonnur, Chikmaglur.	9/12/11, at his office in CCRI, 30 minutes	m.violet@gmail.com	Internet
10.	B.Shivaram	Senior Liason Offcier	Date:9/12/11,	Shivarambhalli	Dr. Violet

		Central Coffee Research Institute, Balehonnur, Chikmaglur.	CCRI, 2 hours	@gmail.com	D'Souza
11.	Dr. Sudhakar S. Bhat	Divisional Head Plant Pathology, Central Coffee Research Institute, Balehonnur, Chikmaglur.	9/12/11, at his office in CCRI,10 minutes	bhatabssk@gmail.com	B.Shivaram
12.	Dr. N.Surya Prakash Rao	Divisional Head Plant Breeding and Genetics, Central Coffee Research Institute, Balehonnur, Chikmaglur.	9/12/11, at his office in CCRI, 15 minutes	nayanirao@yahoo.com	B.Shivaram
13.	Dr. Chadra Gupt Anand	Divisional Head Plant Physiology, Central Coffee Research Institute, Balehonnur, Chikmaglur.	9/12/11, at his office in CCRI, 10 minutes	cganandccri@yahoo.com	B.Shivaram
14.	Bykere Nagesh	Addl.Spl. Representative of Karnataka State	17/12/11, at his house in Bykere, 15 minutes.	bykerenagesh@hotmail.com	Sumathi Basavraj
15.	Jayram Devavrunda &Dinesh Devavrunda	Editor & Publisher, respectively, Krushika Magazine.	22/12/11, at Coffee shop in Sakleshpura, 1 hour	krushika777@gmail.com	Pushpnath Krishnamurthy
16.	Prof. C.G.Kushalappa	College of Forestry Ponnampet South Coorg	23/12/11, at his office in Ponnampet, 1 hour	kushalcg@gmail.com	Dr. Seema (ATREE) & Pushpanath
17.	David Veal	Executive Director, Specialty Coffee	19/1/12, IICF 2012, The	david.veal@scae.com	

		Association of Europe	Lalit, 10 minutes		
18.	Dr. Nandini G.M.	Advisor , Ranadey Export Private Ltd	19/1/12, IICF 2012, The Lalit, 15 minutes		

Annexure 3

List of interviews

Second round of field work: February – March 2014

S.no	Name	Designation	Interview Details (Date/ place/ time)	Contact details	His/her contact was obtained from
1.	Prof. Ambuj Sagar	Professor, Humanities and Social Sciences, IIT Delhi.	Many meetings	0971746644 asagar@hss.iitd.ac.in	Dr. Rohan D'Souza
2.	Dr. Krishna Achutarao	Associate Professor Indian Institute of Technology Delhi Hauz Khas, New Delhi-110016	Many meetings.	9971641104 krishna.achutarao@gmail.com	Prof. Ambuj Sagar
3.	Dr. R. Krishnan	Scientist G Indian Institute of Tropical Meteorology, Pune.	Interacted on email	krish@tropmet.res.in	Dr. Krishna Achutarao
4.	Chellaian Anbarasu	Chief Manager AIC office, 13th Floor, Ambadeep Building, 14, Kasturba Gandhi Marg, New Delhi - 110 001.	09-01-2014 in his office, 2 hours.	canbarasu@aicofindia.com	Direct enquiry at AIC office
5.	Malathi Seetamraju	IMD, Pune	10-01-2014 Interacted on phone, 20 minutes	9850639842 malathi.imd@gmail.com	Chellaian Anbarasu
6.	Dr. K.N. Rao	Earlier General manager AIC. Now with a reinsurance firm in Mumbai.	18-01-14, Telephonic conversation for about half an hour	09167323795 kollirao62@gmail.com	Malathi IMD
7.	Dr. K.K. Singh	Scientist 'F' Agro-meteorologist IMD, New Delhi.	27/1/14, his office Duration of interaction, 1 and half hour	9868110771 kksingh2022@gmail.com	Dr. L.S. Rathord, DG, IMD Delhi. Interacted with him on email
8.	Dr. S.S. Raju	Principal Scientist National Centre for	31-1-14, his office, 45	09958353181 raju@ncap.res.	Direct enquiry at

		Agricultural Economics and Policy Research P.B.No.11305, DPS Pusa Marg, New Delhi 110 012.	minutes	in	NCAP office
9.	Dr. P.K. Agarwal	International Water Management Institute (IWMI) 2nd Floor, CG Block C, NASC Complex, DPS Marg, Pusa, OppTodapur, New Delhi 110 012, India	31-1-14, His office, 15-20 minutes	p.k.aggarwal@cgiar.org	Dr. S.S.Raju
10.	Umesh Mongia	Area Manager ICICI Lombard GIC Ltd 3rd Floor, NarainManjil, 23, Barakhamba Road New Delhi-100001	03-02-14, His office Duration of interaction: 30 minutes	09873076446 umesh.mongia@icicilombard.com	Wrote to Mr. Bhargav Dasgupta (M.D and C.E.O, ICICI Lombard). He connected me to Mr. Rajesh Rai & Mr. Umesh Mongia
11.	Dr. Gopal Iyengar	National Centre for Medium Range Weather Forecasting (NCMRWF) Noida, UP	24/11/2014, NCMWRF office, Noida, 30 minutes.	gopal.iyengar@nic.in, gopal@ncmrwf.gov.in	
12.	Dr. Raghavendra Ashrit	National Centre for Medium Range Weather Forecasting (NCMRWF) Noida, UP	24/11/2014, NCMWRF Library, 1 hour	raghu.ashrit@nic.in raghu@ncmrwf.gov.in	Dr. Iyengar
13.	Dr. D.R.Pattanaik	IMD, Delhi	1/1/15, IMD office, Delhi	drpattanaik@gmail.com	Dr. K.K.Singh
Interview details (Bangalore)					
11.	Dr. Geeta Agnihotri	Director IMD Met Centre, Meteorological Center, Palace road, Bangalore - 5600001 mcbangalore@imdma	11-02-14, IMD office, Bangalore, 1 hour 30 minutes.	09886702921 080-22244419 drgeetaimd@gmail.com	Direct enquiry at IMD Met office, Bangalore.

		il.gov.in			
12.	S.P.Vijayakumar	Tb 01. Third Floor b Block 1 Centre for Ecological sciences, Indian Institute of science, Bangalore - 12 Karnataka, India	11-02-14, at his lab in IISc, Around 1 hour	09481481755 vj@ces.iisc.ernet.in	Dr. Kathik Shankar.
13.	Dr.M.B. Rajegowda	Professor and Head All India Co-ordinated Research Project on Agro-meteorology University of Agricultural Sciences, GKVK, Bangalore-560065 Phone (O):080-23431573 (R):080-23453365	12-02-14, at his office in GKVK, 40 minutes	mbraj2001@yahoo.com 9980366921	Dr. K.K. Singh at IMD, New Delhi.
14.	Viva Kermani	A1, Hidden Nest , 16 Leonard Lane, Richmond Town, Bangalore - 560 025, India. Ph. +91 80 40918235	Many meetings at CSM office.		
15.	Dr. Babu Reddy	Agronomist, Market Research & Intelligence Unit Coffee Board, No.1 Dr. B.R. AmbedkarVeedhi, Bangalore- 560 001, INDIA	13-02-14 & 14-02-14, at his office, 2 hours	Phone:080-22261584, Fax: 080-22255557 Email :ageconomist.cb@gmail.com	Direct enquiry in his office
16.	B. Prabhakar	Officer, AIC Bangalore C/O Karantaka Pradesh KrishiSamaj No.-18, Nrupathunga Road, Hudson Circle, Bangalore- 560001 (Karnataka)	17-02-14,at his office, 15 minutes	080-22115158 08147456806	Dr.Rajegowd at GKVK

17.	D.D. Dange	Regional Manager AIC Bangalore C/O Karantaka Pradesh KrishiSamaj No.-18, Nrupathunga Road, Hudson Circle, Bangalore- 560001 (Karnataka) Ph. No.- (080-22115158)	17-02-14,at his office, 30 minutes.	080-22115501 dddange@aicofindia.com	Mr. Prabhakar
18.	Dr. V.S. Prakash	Director Karnataka State Natural Disaster Monitoring Centre, KSNDMC Campus, Major Sandeep Unnikrishnan Road ,Near Attur Layout, Yelahanka Bangalore - 560 064, Karnataka, INDIA, Phone No :+91 080 67355000 Email: dmc.kar@nic.in, dmc.kar@gmail.com	17-02-14, at his office, 30 minutes	prakash.vshiva@gmail.com 09740777700	Dr. K.K.Singh at IMD
19.	Dr.C.N.Prabhu	Scientist -do-	17-02-14, at his office, 30 minutes	dmc.kar@nic.in, dmc.kar@gmail.com	Dr. V.S. Prakash
20.	Gavaskar	Statistician -do-	17-02-14 and 25-02-14, at his office and at C-MMACS, 1 hour	-do-	-do-
21.	Dr. T.R. Ramamohan	Director, CSIR Center for Mathematical Modeling and Computer Simulation (C-MMACS), NAL Belure Campus Bangalore, 560037 India.	25-02-14, at his office, 15- 20 minutes.		Direct enquiry at C-MMACS office
22.	Dr. K.V. Ramesh	Scientist	25-02-14, at	080 2505	Dr.

		-do-	his office, 15- 20 minutes.	1351(Off) 094483 757 12(Mob) ramesh@cmmacs.ernet.in kvram55@yahoo.com	T.R.Rammohan
23.	Dr. V Rakesh	Scientist	25-02-14, at his office, 15- 20 minutes.	rakesh@cmmacs.ernet.in +91-8050892072 Off- +91-8025051332	Dr. K.V. Ramesh
24.	Dr. N.K. Indra	Scientist -do-	25-02-14, at his office, 15- 20 minutes.		Dr. Rammohan
25.	Dr. Vinod Kumar	Head, Division of Entomology, Central Coffee Research Institute, Balehonnur, Chikmaglur	04-03-14,CCRI campus Chickmaglur, interacted many times during the stay at CCRI	09449559112 i2vinod03@gmail.com	Dr. Raghuramullu
26.	Dr. J.S. Nagaraja	Agricultural chemist -do-	04-03-14,CCRI campus, over 2 hours	09449498864 jsnraj2003@yahoo.co.in	Dr. Vinod Kumar
27.	Dr. Sudhakar S. Bhat	Divisional Head Plant Pathology, -do-	05-03-14, CCRI campus, 2 hours.	09449747721 bhatabssk@gmail.com	Dr. Vinod Kumar
28.	Dr. Jena Devasia	Asst. Plant Breeder Department, Department of Plant Breeding and Genetics. -do-	05-03-14, CCRI plantations, over 2 hours	08277062267 Jeena.devasia@gmail.com	Dr. Vinod Kumar
29.	Dr. Raghuramulu	Director, -do-	06-03-14, CCRI campus, 20 minutes	09480075930 jdrccri@gmail.com	Interacted during initial field work in 2011
30.	Dr. N.Surya	Divisional Head	06-03-14,	0948157873	Dr. Vinod

	Prakash Rao	Plant Breeding and Genetics, -do-	CCRI plantations, over 2 hours	2 nayanirao@yahoo.com	Kumar

Growers' interview details

S.no	**Name**	**Address**	**Contact details**	**Interview Details**	**His/her contact was obtained from**
1.	Y.S. Girish		ysgirishskp@gmail.com 09731259910	19-02-14, at HDPA office 2 hours	Dr. Pradeep during 2011 field work
2.	Dr. Anand Pereira	Joe's Sustainable Farm Kirehully Estate Sundekere Post SakleshpuraTaluk Hassan District	anandpereira9@gmail.com 08173329231	21-02-14, at his estate, 4 hours	During 2011 field work
3.	Basanna Hosakere	Anne Mahal Village, SakleshpuraTaluk	basannahr@gmail.com 09141760389	21-02-14, his estate, over 2 hours	-do-
4.	Ravinder Kannan	7-3-8 D, Batlagundu Main Road, Pattiveeranpattu-624211, Dindigul District, Tamil Nadu	kannan58@gmail.com 09443855284	Interacted many times between 26-2-14 to 28-2-14, his plantations, Over 5 hrs.	Viva Kermani
5.	T.Krishnamurthy	7-3-8 D, Batlagundu Main road, Pattiveeranpatti-624211, Dindiguldistrict, Tamil Nadu	ntkrish@rediffmail.com 09865613399	26-2-14 and 27-2-14, at his house and his plantation, over 5 hrs.	Ravinder Kannan
6.	Parthasarthy	Perumparai, Manalur Panchayat,		27-2-14, at his plantation, over 2 hrs.	Ravinder Kannan

		AthoorTaluk, Dindigul, Tamil Nadu			
7.	Vijay Shekhar	Semmadioothu, KC patty, PaliniTaluk, Dindigul district, Tamil Nadu		26-2-14, Pattiveeranpattipalnters club, 30 minutes	Ravinder Kannan
8.	Pradeep	Ammikulavi, KC patty, PaliniTaluk, Dindigul district, Tamil Nadu		26-2-14 evening and 27-2-14 evening, Pattiveeranpattipalnters club, 15-20 minutes	Ravinder Kannan
9.	Mohan	Ammikulavi, KC patty, PaliniTaluk, Dindigul district, Tamil Nadu		26-2-14 evening, Pattiveeranpattipalnters club,15-20 minutes	Ravinder Kannan
10.	Mahesh Narayan	Kanalkadu ,kodaikanal taluk, Teeni district. Tamil Nadu	09842199516, 09489268656, 9526152426	28-2-14 , visited all his plantations, over 5 hours.	Ravinder Kannan
11.	P.Soundrapandian	12-2-6A, W.P.A.S compound, Pattiveeranpatti-624211, Dindigul District, Tami Nadu, India.	fruitsnbeans@yahoo.co.in 09489382329	27-2-14, Pattiveeranpattipalnters club, 30 minutes	Ravinder Kannan

Annexure 4

List of interviews

Third round of field work: January – March 2015

Details of coffee growers interviewed

S.No	Name	Estate address	Date, time and place of the interview	Contact details	Contact obtained from
1.	Mahendra	Ponnathmotte Estate, Mathikad Post Via Sunticoppa, North Coorg, Karnataka-571237	6/1/15, at his house	098386093	Chetalli planters' gathering
2.	Rajesh Dayananda	Nargane coffee, Sunticoppa, N. Coorg	6/1/2015, at Mr. Mahedra's house, 9.30 pm.	9448874111, rajeshdayananda@gmail.com	Chetalli planters' gathering
3.	Appaiah	Silver Dream Estate and Home Stay Ibnivalavadi village, Boikeri-571201, North Coorg, Karnataka.	7/1/15, at his house	09449755341, sildreamestate@gmail.com	Mahendra
4.	S. Dilip Appachu	Kotagiri Estate, Chettali, North Coorg	8/1/15, at his house	09448976794, diliphappachu@gmail.com	Mahendra
5.	Capt. M.P. Thimmaiah	Chettalli, Somarpet Post, North Coorg	8/1/15, Chetalli Planters' club	09986093621, 08276-266606	Mahendra
6.	Nanda Balliapa	Madapur, Somarpet Taluk	6/1/15, at his plantation	9448034416	Dr. Pradeep
7.	Hema Mahendra	Ponnathmotte Estate, Mathikad Post Via Sunticoppa, North Coorg, Karnataka	8/1/15, at her house	9483110556	Mahendra
8.	Niranjan	Nava Nidhi	13/1/2015,		Met him at

		Estate, Pasaranhally village, Kianara Post, Chikmaglur district	Coffee Board Library		the coffee board library
9.	Dinesh Devarunda	Jakad Plantations Devarunda village & Post, Mudigere, Chikmaglur	18/1/2015, On the way from Bangalore to Mudegere, Chikmaglur	09483811333 krushika777 @gmail.com	From 2011 field work
10.	C.B. Deviah	P.O Box #17, Matadakad Estate, Suntikoppa, Kodagu- 571237	18/1/2015, Mudigere, Chikmaglure		
11.	K.C. Karunananda		18/1/2015, Mudigere, Chikmaglure	9448005322	at the BGL gathering
12.	Sai Muthana		18/1/2015, Mudigere, Chikmaglure	8762515201	at the BGL gathering
13.	Anand D'Souza		18/1/2015, Mudigere, Chikmaglure	09448554801, 08262-254089	At the BGL gathering
14.	B.R.Yathiraj	Ganga Bhavani Estate, Handi-577111, Chickmaglur	19/1/2015, at his home.	09448055057	Radhika Yathiraj
15.	Radhika Yathiraj	-do-	18/1/2015, at her house	09448868777	At the BGL gathering
16.	Peter Mathias	No.36, Rest house Cresent, Bangalore-560001	23/1/2015, 9.30 am, at his house	09448971433	From Mphil field work
17.	Mahesh Shahidhar		27/1/2015, 6.30 am to 10.30 am. On the way from Bangalore to Chikmaglur	09448148340	B.R.Yathiraj
18.	K. Kurien	Managing Director Devon Plantations	27/1/2015, at Kadur Planters' Club,	09448384403 kurian@devonsestates.in	Mahesh Shahidhar

		3rd floor, 29, Infantry Road, Bangalore-560001	Chikmaglur		
19.	Baba P.S. Bedi	Kogode estate, Nagenahally Belur Taluk Hassan District	27/1/2015	Baba_bedi@hotmail.com babapsbedi@gmail.com 09448057441 09449005441	-do-
20.	Dr. Khalid Aldur		27/1/2015, 11.30 am, KPA office, Chikmaglur	09448050032	KPA gathering
21.	Jeevan Balliappa	Balehonnur, Chikmaglur	27/1/2015, 11.30 am, KPA office, Chikmaglur	9448999610	KPA gathering
22.	P.A. Poonacha	Manager, Badra Estates & Industries Ltd., Bettadakhan Estate Pandarvalli-577131 Chikmaglur District	27/1/2015, 2.30 pm, kadur Planters' club office, Chikmaglur	09194498372 79 papoonacha@yahoo.com papoonacha@gmail.com	KPA gathering
23.	Marvin Rodrigues	Heggadde Estates, Norway-573127, Hassan district Bangalore address: A-2, Brunton Rustumji, 21 Brunton Road Bangalore	11/2/2015 4.30 pm. Met him at his residence in Bangalore. 19/2/15 and 20/2/15 visited his plantation in Sakleshpur.	09880133722 heggaddeestates@gmail.com	Anil at Hindu Business Line.
24.	Virendra Vishwanath		19/2/15		
25.	Vijayan Rajes	President United Planters' Association of Southern India	15/3/15 4.30pm at his house. 73/2 2nd cross, Levell road	09443226612 vrajes@ymail.com	Marvin Rodrigues.

Other interviews

S.No	Name and	designation	Date, time and place of the interview	Contact details	Contact obtained from
1.	Ananth Kumar	Deputy Director (E) Coffee Board Medikeri	Telephonic interview, 13th January 8-8.30pm	09449835518	Met him at the Chettali meeting.
2.	Dr. Hemla Naik	Dean University of Agriculture & Horticulture Sciences, Shimoga University	18/1/2015, discussion during the conference and afterwards during the visit to Mr.Keshava's place.	09448862225	Met him At the Black Gold League training session.
3.	Dr. Y. Raghu ramulu	Director of Research, Central Coffee Research Institute, Coffee Research Station Post - 577 117 Chikamagaluru District, Karnataka.	22/1/15 , 12/2/15 and 13/2/15, Coffee Board Bangalore and Central Coffee Research Institute, Chikmaglur.	Phone : 08265-243029 (O), Mob: 9480075930 Res : 08265-243007 / 243016 Fax : 08265-243143 E-mail: jdrccri@gmail.com, dr.coffeeboard@nic.in	From Mphil work
4.	Dr. Stephen D. Samuel	Deputy Director Research, Coffee Board Substation, Chetalli, Somwarpet taluk, Kodagu District, Karnataka.	22/1/15, 4.00 pm, Coffee Board, Bangalore	09481788575 (p), 09481288726 (o) sdsamuel@gmail.com dydircrss@gmial.com	Ananth Kumar
5.	Megha Prakash	Consultant editor Connect IISc Magazine	22/1/15 and 3/2/15 IISc Campus, Bangalore	prakash.megha@gmail.com 09880334369	Continuous engagement since 2011
6.	Nathan Price	Chief Agronomist Yara Asia Pvt Ltd	27/1/15, KPA office, Chikmaglur, Chief Agronomist, Yara Asia.	06581233963 nathan.price@yara.com	Met him during the KPA meeting in Chikmaglur
7.	Dr.	Director of Finance	29/1/15, Coffee	Office:	Direct

	Aarti Dewan Gupta	Coffee Board	Board Office	22257690 Res: 25342276 dirfin.coffeeboard@nic.in	enquiry at coffee Board
8.	Dr. Babu Reddy	Agronomist, Coffee Board	29/1/15 and 9/2/15 Coffee Board Office	Office: 22261584 ddmr.coffeeboard@nic.in	Continuous engagement since 2011
9.	Prof. A. Damodaran	Professor, Economics & Social Sciences Area, Chair Professor IPR Chair on IP Management (MHRD)	30/1/15, 11.30am, IIM Bangalore campus	09742221307 damodaran@iimb.ernet.in	Aparna Dutta
10.	Anil Raje Urs	Principal Correspondent, Hindu Business Line	30/1/15, 4 pm, Hindu Business line office, 19 &21, Bhagwan Mahaveer Road, Bengaluru	08030854081, 09880829145 Anil.u@thehindu.co.in	Direct enquiry at Hindu Business line office, Bengaluru.
11.	Dr. Vijayakumar. A. N	Associate Professor (Finance and Control), Indian Institute of Plantation Management	2/2/15, Indian Institute of Plantation Management, Jana Bharathi Campus, P.O Malathalli, Bangalore-560056	09844361528, 8553585777 anvijayakumar@gmail.com	Anil Raje Urs
12.	Prof. V.G.Dhanakumar	Director, Indian Institute of Plantation Management.	2/2/15, Indian Institute of Plantation Management, Jana Bharathi Campus, P.O Malathalli, Bangalore-560056	08023211716, 08023212773, director@iipmb.edu.in/vgdkumar@vsnl.net	IIPM Visit
13.	Dr. Ashwini	Coffee Board Chair Assistant Professor, Indian Institute of Plantation Management	2/2/15, Indian Institute of Plantation Management, Jana Bharathi Campus, P.O	09448544902 ashwiniiipmb@gmail.com	Coffee Board library

			Malathalli, Bangalore-560056		
14.	Dr. kartik Shankar	Associate Professor, Centre for Ecological Studies, IISc	3/2/15, at his office in IISc	kshanker@gmail.com	Aarthi Sridhar
15.	Dr. M. Pandurangaa Vithal	Professor of Finance and Strategy Indian Institute of Plantation Management	4/2/15, 10.30 am Indian Institute of Plantation Management, Jana Bharathi Campus, P.O Malathalli, Bangalore-560056	080-23211716, 080-23213336	Prof. V.G.Dhanakumar
16.	D.K. Nagendra	Consultant- Promotion Coffee Board	5/2/15, 11.00 am, Coffee Board Office, Bangalore	080-22255920, adpdkn@gmail.com	Dr. Aarti Dewan Gupta
17.	Sunalini Menon	Board of membet Tata Coffees, Chief Executive, Coffee lab private Ltd.	9/2/15, 5.00pm, # 471, 10th main, Raj Mahal Villa, Extension, Bengaluru	080-23610722 / 23617881, coffeelab@vsnl.com	Continuous engagement since 2011
18.	M.N. Jaideep	Sr. General Manager J.Thompson and Corporation Pvt Ltd	10/2/15, 11.00 am 509, 5th Floor, South Block, Manipal Centre, 47, Dickeson Road, Bangalore	09448484063 Bangalore@jthomas.in	Anil Raje and Mr. D.K. Nagendra
19.	P.J. Suresh Babu	Proprietor Chaithanyaa Coffee	19/2/15, 11.00 am, Auction hall, Coffee Board	09448058914, 9342630516 chaithanyaacoffee@gmail.com, chcoffee@bgl.vsnl.net.in	Met him during the auction
20.	K.S.Medapa	Director Forbes, Ewart & Figgis (P) Ltd	19/2/15, 11.20 am, Auction hall, Coffee Board	080-22237770, fefblr@vsnl.com	Met him during the auction.
21.	Prof. P.G. Chengappa	National Professor of ICAR, Institute of Social and Economic Change, Dr.	11/2/15, 11.30am Institute of Social and Economic Change.	09980418210 chengappa@isec.ac.in chengappapg@g	Through planters in Chettali (Coorg)

		VKRV Road, Nagarabhavi, Bangalore-560072		mail.com	
22.	Dr. Vinod Kumar	Head, Division of Entomology Central Coffee Research Institute, Balehonnur, Chikmaglur	12/2/15, 4.00pm , CCRI, Balehonnur, Chikmaglur	09449559112 i2vinod03@gmail.com	Dr. Raghuramullu
23.	Dr. Chadra Gupt Anand	Divisional Head Plant Physiology, Central Coffee Research Institute, Balehonnur, Chikmaglur	12/2/15, 5.00pm, CCRI Balehonnur	094804-87849 cganandccri@yahoo.com	Continuous engagement since 2011
24.	Dr. Jeena Davis	Asst. Plant Breeder Department, Department of Plant Breeding and Genetics	13/2/15, 11.30am, CCRI Balehonnur	08277062267 Jeena.devasia@gmail.com	Dr. Vinod Kumar in 2014
25.	C. Anbarasu	Chief Regional Manager Agriculture Insurance Company of India Ltd. Bangalore	18/2/15, 11.00am, AIC head office Bangalore, 3rd Floor, karnataka Pradesh Krishik Samaj, Hudson circle, Bangalore	09945987908 canbarasu@aicofindia.com	Met him in Delhi in 2014
26.	Praveen B.R	Assistant Manager Agriculture Insurance Company of India Ltd. Bangalore.	18/2/15, 11.30am, AIC head office Bangalore, 3rd Floor, karnataka Pradesh Krishik Samaj, Hudson circle, Bangalore	08970021543 praveenk@aicofindia.com	C. Anbarasu
27.	Meera Ooman	Dakshin Foundation, Flat No. A-001, Samvriddhi Gardenia Apartments, 88/3, Byataranapura, near Sahakar Nagar A Block, Bangalore 560 092		09901469315 meera.anna@gmail.com	Dr. kartik Shankar
28.	Amit Pant	Vice President Sales and Marketing Tata Coffee Limited	25/2/15, 11.30am, 57, Railway Parallel Road, Kumara Park West, Bengaluru-560020	09945029363 amit.pant@tatacoffee.com	Sunalini Menon

29.	Pushpnath Krishnamurthy	Director, Programme and Advocacy Centre For Social Markets.	26/2/2015, 12.00pm A-1, Hidden Nest, 16 Leonard Lane, Richmond Town,Bangalore 5600 025, India +91 80 40918295	09884914836 09916817647 pushpanath@btinternet.com pushpanflow@gmail.com	Continuous engagement through 2011
30.	Dr. R. Krishnan	Scientist G Indian Institute of Tropical Meterology, Pune.	2/3/15, IITM campus	krish@tropmet.res.in	Dr. Krishna Achutarao
31.	Dr. Milind Mujumdar	Scientist D Indian Institute of Tropical Meterology, Pune.	3/3/15, 3.30pm, IITM campus	mujum@tropmet.res.in	Dr.R.Krishnan
32.	Dr. J. Sanjay	Scientist D Indian Institute of Tropical Meterology, Pune	3/3/15, 3.30 pm, IITM campus	sanjay@tropmet.res.in	Dr. R. Krishnan
33.	Dr. B. Mukhopadhyay	Deputy Director, General of Meteorology (climatology), and the current Additional Director general of Meteorology, IMD Pune.	4/3/15, IMD Pune	09960334388, mukhoddg@gmail.com	Dr. K.K. Singh
34.	Dr. A.K.Srivastava	Scientist E Director, National Climate Centre Office of the Additional Director Genral of Meteorology(Research) IMD, Shivajinagar, Pune-411005	4/3/15, IMD Pune	0922305632, aks_ncc2004@yahoo.co.in akssrivastava@hotmail.com	Dr. B. Mukhopadhyay
35.	Dr. P. Guhathakurta	Scientist E Head, Hydrometeorology Office of the Additional Director Genral of Meteorology(Research) IMD, Shivajinagar, Pune-411005	4/3/15, IMD Pune	09423585997 pguhathakurta@rediffmail.com pguha_imd@yahoo.co.in	Dr. A.K.Srivastava
36.	Dr. D.Sivananda Pai	Scientist E& Head of Long Range Forecasting Division Office of the Additional	4/3/15, IMD Pune	09422313758 ds67.pai@imd.gov.in sivapai@hotmail	Dr. A.K.Srivastava

		Director Genral of Meteorology(Research) Indian Meteorological Department, Shivajinagar, Pune-411005		.com	
37.	C.P. Cheng appa	Senior Manager Tata Coffee Limited, Cottabetta Estate PB No16 Pollibetta - 571215 Kodagu District Karnataka	9/3/15, Cottabetta Estate, Pollibetta, Kodagu.	082724-251416 cpc@tatacoffee.c om	Amit Pant's office
38.	M.B. Ganap athy	Senior General Manager-Plantations Tata Coffee Limited Pollibetta -571215 Kodagu District Karnataka	9/3/15, 4.00 pm Tata Coffee head office in Pollibetta.	09448100705 mb.ganapathy@t atacoffee.com	Amit Pant's office
39.	R. Joshua Amrith araj	Senior Manager- R& D Tata Coffee Limited Pollibetta -571215 Kodagu District Karnataka	9/3/15, 4.30 pm Tata Coffee head office in Pollibetta.	08274-251411 Amirtharaj.rj@ta tacoffee.com	Amit Pant's office
40.	Dr. Amir Bazaz	Consultant- Practice Indian Institute for Human Settlements	12/3/15, 11.30am, IIHS Campus, No.197/36, 2nd Main Road, Sadashiv Nagar, Bengaluru	09920420992 abazaz@iihs.ac.i n	Dr. Milind Majumdar
41.	Aparn a Dutta	Communication Lead Techno Serve	14/3/15, 5.00pm, At her home 1-C Fernhill Gardens, East Wing (Block E2) HSR layout	09845015947 adatta@tns.org penscape@rediff mail.com	Continuous engagement through 2011

Annexure 5

List of Survey Respondents (Growers) at the BGL Training Session

Date:18/01/2015
Time: 10.30 a.m
Place: Horticulture College Mudigere, Chikmaglur, Karnataka

S.no	Name	Address	Contact number
1.	C.R. Shivakumar	Hebbattageri Village, K. Nagugane Post, Medikeri.	9448005614
2.	K.M. Rajan Appanna	Palace Field and Estate, P.B # 55, Medikeri-571201	9845132844
3.	C.S. Guruduth	Mithila Estate, Ashwini Road, Medikeri	0944721312, guruduth@gmail.com
4.	M.C. Muthanna	Chowdi Range Estate, p.b 10, Siddapur-571253, Kodagu district	9845907227
5.	C.S. Dhananjay	Jayanagar, Near Sudarshan Circle, Medikeri-571201, Kodagu	9448588083
6.	N.S. Ajaygopal	Sri Laxmi estate, Kandanakolly Post Via Medikeri, Coorg District	9986331429
7.	Ashithosh	Subbganga Estate, Arshinguppe, Mallenhalli Post, Chikmaglur	980322261
8.	C.B. Deviah	P.O Box #17, Matadakad Estate, Suntikoppa, Kodagu-571237	
9.	K.C. Mohan	Keragodu, Arehalli Post, Belur Taluq, hassan District-573101	9900906887
10.	Sai Muthama K.	Maday Estate, Medikeri, kodogu - 571201	8762515201
11.	Dr. K.Sunil Muddaiah	Springdale Estate, Arapattu, Pudavnada, Virajpet-571218, kodagu	cids_coorg@cids.edu
12.	Shikanth Ravi	Sree Krishna Estate, Hatti Hole Post Via madapur, N. Coorg	081978774884, 08272203099
13.	Nithin. K.V	Sri Nidhi Plantations, Chennahally Po, Palya Hobli, Alur Taluq, hassan District	094820-99900
14.	Shreyas. G.L.	S/O I.R. Lakshmi Narayan, Chikkolale, Kabbinahalli	shreyasglgowd

		Post, Chikmaglur-577101	a86@gmail.co m
15.	Nirup B.B.	Bygoor Estate, Avathi post, Chikmaglur.	
16.	S.T. Arasu	Kalasa Estate, Kalasa-577124, Chikmaglur	
17.	M.S. Nagaraj	Mahal Gode Estate, Magundi, Balehonnur, Chikmaglur	09343703796, 09481451279
18.	H.H. Suresh	Heddlu, Kuduvalli post, Chikmaglur taluq- 577133	9342278787
19.	P.S. Narayana,	Hosmane Estate, Pattadur Village, Billur post, Mudigere taluq, Chikmaglur	9242848199
20.	Suman Menezes	Pompei Kripa Estate. Bankal P.O, Mudigere, Chikmaglur	9449651360
21.	Anand misquilt	Blue Mount View Estate, P.O Banhal - 577113, Mudigere, Chikmaglur	
22.	Neethan Aranha	Malligehani Estate, K.Kelagur Post via Balehole, Chikmaglur-577179	9449591632
23.	Malcom D'Souza	ST Rita's Estate, Bankal, Chikmaglur-577113	9742849262
24.		Boothankad estate, handi Post-577111, Chikmaglur	
25.	Chanchal K.N	Sree RamKrupa Estate, Mallenhalli P.O, Chikmaglur	8762833355
26.	Vishwas	Malliya Cool Estate, mallenhalli Post, Chikamglur	098452-31389
27.	B.G. Devendra	Chandravalley, Bidar Post, Chikmaglur-577136	9448665234
28.	Anand P D'Souza	Madeneralu Estate, kelagur Post, Via Adlur, Chikmaglur -577111	09448554801, 08262-254089
29.	Santhosh H.K.	S/o H.P. Kanttraj, Kulbyle estate, Hebsale, Sakleshpur	9620515525
30.		Harley Estates, Kumbarodi Port, Sakleshpur	
31.	Nayana Santosh	Chikly Estate, mallandur, Chikmaglur	
32.	Radhika Yathiraj	Ganga Bhavani Estate, Handi-577111, Chickmaglur	9448868777
33.	A.S. Chandra Prakash	Chandrika Estate, P.B. No. 61, Chikmaglur-577101	09844076763, 08762776763
34.	Nataraj H.S.	Prashanth Estate, Basarikatte Post-577114, Koppa, Chikmaglur	9535659723
35.	H.V. Sadashiva	Hosahalli, Belavinakodge, Koppa, Chikmaglur	7353569902
36.	Yogananda B.S	S/O Sheshagiri Rao B.S, Byredevaru, Shantigrama Post, Koppa, Chikmaglur	9448218395

37.	T. Chitraksha	Bitteshwara, T.D. Halli Estate & Post, Arehalli-573101	
38.	B.G. Kadappa	Vasundara Farm, Begave, Sringeri	
39.	K.M. Chandrashekra	Kalkuly Estate, Sringeri	
40.	M.V. Pratheek	Venkateshwara Estate, Bitteshwara, T.D. Halli Post, Arehalli, Hassan	
41.	Manoj Hegde	Kalkedli, Tekkar, Sringeri, Chikmaglur-577139	
42.	H.R. Pradeep	Dunduga, Halase PO Mudigere, Chikmaglur	
43.	Najam	Green Valley estate, Adlur, Chikmaglur	9449793393
44.	Y.N. Padmanabha	Moodusosi Estate, Cheekanahalli (Post), Belur, Hassan- 573115	
45.	K.C. Karunananda	Vanamala Estate, Channapura-573128, Kundur Post, Alur, Hassan	9448005322
46.	Prahdan Nagesh	Vijaya Estate, Makonhalli Post, Mudigere, Chikmaglur	pradhan.nagesh@gmail.com
47.	Dr. Vivek	Vayu Channapura Road, Kote, Chikmaglur-5770101	09900495590, 09480028688
48.	Sreepal	Nandini Estate, Elechan, Aldur, Chikmaglur	099001-62552
49.	A.S. Mallesh	Chandraprasad Estate, Beligeri Post, Nandimotte Madapur - 5712251	9448108154
50.	A.C. Santosh	Chikly Estate, Mallandur, Chikmaglur-577101	9341011900
51.	Dr. B.T. Suresh	Bakkaravally, Malasavara Post, Belur taluk, Hassn District- 573101	sureshthammiah@gmail.com, 09741889411
52.	Varendra M.B	Bitteshwara Estate, T.D. Halli Post, Arehalli-573101, Belur, Hassan	9972021255
53.	V. Kishor	Geergal Estate, Malasavara, Belur Taluk	9449659297
54.	H. B. Murugeshthappa	Hedre Village, Mayakanda post, Devanagere Taluk	9886924269
55.	Samrat C.L.	Chitervalli Village, Chikmaglur-577101	9886994778
56.	Pavan Sudev	Eachalavath Estate, Kabbinagaddi, hallebedu Post, Sakleshpura	
57.	M.G. Ramesh	Chandapura EstateKushavara post, Belur Taluk, Hassan - 573215	
58.	M.S. Jaiprakash	Mahalgod estate , Lekha Niwas, Hosmane Road, Chikmaglur	
59.	Kaushik Kadumane	Mallige khan Estate, K. Thalagur, Mudigere	9741411229

60.	Shashwath	Bechalekan Estate, Arastinaguppa	9916137777
61.	K.R.Keshava	Hosathota Estate, Kenjige Post and Village, Mudigere Taluk, Chikmaglur, Karnataka	9448340900

Annexure 6

List of Participant Coffee Growers in Group Discussions and Association Meetings

S.no	Name	Address	Contact
1.	K.A. Cariappa	Harima Estate, Nakoor Shriangala, Sunticoppa, North Coorg.	9448561444
2.	B.A. Poonoche	Dy, Commissoner of Police, karnataka, Jaylaxmi estate, Madapura, Kodagu-571251	9448709763
3.	Sathish C.T	Nani Estate, Horoor Post, Sunticoppa	9448433128
4.	K.M.Manohar	Krishnagiri estate, Boikeri Post, Madikeri, North Coorg	9480853185
5.	M.G. Hoysala	Sri, Siddalingeshwara Estate, Hardur Post, Sunticoppa North Coorg-571237	hoysala.mg@gmail.com
6.	B.M. Devaiah	Eravalamudi village, Chettalli	9483566878
7.	R. M. Achappa	Farm View Estate, Cherala Sri Mangla Village, Chettali Post	9480556929
8.	M.P. Devaiah	Chettalli	9482762575
9.	P.K. Subhaiah	Ganesh Cherala Estate, Chettalli	8861238972
10.	M.M. Ranjan	Vrimangala Estate, Chettalli	8861238972
11.	K.A. Thammaiah	Hari-Ma Estate Sunticoppa	944997877
12.	P.P. Jayananda	Chettalli area	9448813547
13.	D.S. Harish	Chettalli area	9448976364
14.	M. Rathu Changappa	Sunticoppa, Coorg	9481858860
15.	B.B. Madaya	Chettalli	9448387774
16.	A. Thara Aiyamma	Neela Estate, Balele-571219, Virajpet Taluk, South Kodagu	9845663637

17.	M.C. Muddappa	Pragathi Plantation, P.B. 60, B.D.O Road, Somarpet-571236, Kodagu District	9448504480
18.	Rabello	Gonebidu	9448165972
19.	Ranveer	Chikmaglur	9448317034

Annexure 7

List of Native Trees Found in Coffee Estates in Western Ghats

S.no.	Kannada name	Botanical name
1.	Attimara	*Ficus recemosa*
2.	Goni	*Begonia rex*
3.	Basari mara	*Ficus virens*
4.	Bili Basari	*Ficus amplissima*
5.	Honne	*Pterocarpus marsupium*
6.	Beete	*Dalbergia latifolia*
7.	Nandi	*Tabernaemontana divaricata*
8.	Nalli	*Phyllanthus emblica*
9.	Havalige	*Acrocarpus fraxinifolius*
10.	Kooli	*Ligustrum perrottetii*
11.	Halasu	*Artocarpus altilis*
12.	Vaate	*Thottea siliquosa*
13.	Baage	*Albizia odoratissima*
14.	Kunkuma	*Mallotus philippensis*
15.	Maagali	*Decalepis hamiltonii*
16.	Mitala	*Streblus asper*
17.	Mahogani	*Swietenia macrophylla*
18.	Godda	*Lannea coromandelica*
19.	Kakke	*Lantana camara*
20.	Aelele Haale	*Alstonia scholaris*
21.	Samudra haale	*Argyreia nervosa*
22.	Bakula	*Manilkara hexandra*
24.	Neeru pale	*Wendlandia thyrsoidea*
25	Honge	*Pongamia pinnata*
26.	Sampige	*Magnolia champaca*
27.	Garagatti	*Ficus exasperate*
28.	Mukhyamuttage	*Aphanamixis polystachya*
29.	Haadaga	*Sesbania grandiflora*
30.	Neralu	*Syzygium cumini*
31.	Kadu baage	*Albizia odoratissima*
32.	Betta Baage	*Albizia chinesnsis*
33	Kapura	*Cinnamomum camphora*
34.	Nirvala	*Crateva adansonii*
35.	Achenge	*Saraca asoca*
36.	Ambati	*Embelia tsjeriam-cottam*
37.	Buruga	*Cochlospermum religiosum*

Annexure 8

Member Association of Karnataka Growers' Federation (KGF)

Karnataka Growers' Federation		
Chikmaglur	21. Hegadde Panchayath Belegarara Sangha	42. Dundalli Panchayath Belegarara Sangha
1. C.K. M.Kasaba Belegarara Sangha	22. Belagodu Hobli Belegarara Sangha	43. Nidtha Panchayath Belegarara Sangha
2. Avathi Sanna Coffee Belegarara Sangha	23. Belagodu Panchayath Belegarara Sangha	44. Shanivarasanthe Panchayath Belegarara Sangha
3. Sayadri Coffee Belegarara Sangha	24. Kasaba Hobli Belegarara Sangha	45. Gowdalli Shanivarasanthe Panchayath Belegarara Sangha
4. Mudigere Taluk Coffee Belegarara Sangha	25. Halsulige Panchayath Belegarara Sangha	46. Kodagu Growers' Federation
5. Gonibeedu Hobli Belegarara Sangha	26. Kyanahalli Panchayath Belegarara Sangha	47. Somvarpet Taluk Belegarara Sangha
6. BelurKalasa Hobli Belegarara Sangha	27. Anemahal Panchayath Belegarara Sangha	48. Kodagu District Planters' Association
7. Kandya Hobli Belegarara Sangha	28. Malali Panchayath Belegarara Sangha	49. Jamboor Panchayath Belegarara Sangha
8. Aldur Hobli Belegarara Sangha	29.Biradalli Panchayath Belegarara Sangha	50. Biligeri Panchayath Belegarara Sangha
9. Vasthare Hobli Belegarara Sangha	30. Hebbasale Panchayath Belegarara Sangha	51. Garvale Panchayath Belegarara Sangha
Hassan (Sakleshpur)	31. Alur Taluk Coffee Belegarara Sangha	52. Iggodlu, Muvathoklu & Hadagere Panchayath Belegarara Sangha
10. Hassan Jilla Planters' Sanga	32. K. Hoskote Panchayath Belegarara Sangha	53. Kandanakolly Panchayath Belegarara Sangha
11. Yaslur Hobli Belegarara Sangha	33. Karantaka Belegarara Sangha, Arehalli	54. Mukkodlu Panchayath Belegarara Sangha
12.Changdihalli Panchayath Belegarara Sangha	34. Arehalli Panchayath Belegarara Sangha	55. Boikeri Panchayath Belegarara Sangha
13. Hoosur Panchayath Belegarara Sangha	35. Norway Panchayath Belegarara Sangha	56. Kedakai Panchayath Belegarara Sangha
14. Uccanghi Panchayath Belegarara Sangha	36. Anugatta Panchayath Belegarara Sangha	57. Nakoor Panchayath Belegarara Sangha
15. Igoor Panchayath Belegarara Sangha	37. Malasavara Panchayath Belegarara Sangha	58. Chettali Panchayath Belegarara Sangha
16. Hettur Panchayath Belegarara Sangha	38. T.D. Halli Panchayath Belegarara Sangha	59. Kajoor Panchayath Belegarara Sangha
17. Vanugoor Panchayath Belegarara Sangha	39. Wattehalli Panchayath Belegarara Sangha	60. Kirgandir and Takeri Panchayath Belegarara Sangha
18. Attihalli Panchayath Belegarara Sangha	**Kodagu**	
19. Kurubattur Panchayath	40. Shanivarasanthe Hobli	

Belegarara Sangha	Belegarara Sangha	
20. Hanbal Hobli Belegarara Sangha	41. Handli Panchayath Belegarara Sangha	

Annexure 9

Association members United Planters' Association of South India (UPASI)

1. All India Coffee and Produce Merchants Association
2. Anamallai Planters' Association
3. Association of Planters of Kerala
4. Bombay Tea Trade Association
5. Cardamom Marketing Corporation
6. Cardamom Planters' Association
7. Central Travancore Planters' Association
8. Chay Vyapar Sangh
9. Coonoor Tea Trade Association
10. Kodagu Planters Association
11. Coffee Exporters'; Association
12. Kanna Devan Planters' association
13. Kanyakumari Districts Planters' Association
14. Karnataka Planters' Association
15. Kerala Cardamom Growers Association
16. Malabar Planters' Association
17. Mundakayam Planters' Association
18. Nelliampathy Planters' Association
19. Nilgiri Small Tea Growers' Association
20. Nilgriri Bought Tea Leaf Manufacturers' Association
21. Nilgiri Planters' Association
22. Nigiri-Wynaad Planters' Association
23. Planters' Association of Chikmaglur
24. Shevroy Planters' Association
25. Tea Trade Association of Cochin
26. Tea Trade Association of Coimbatore
27. Wynaad Coffee Growers' Association
28. Wynaad Planters' Association

Annexure 10

Questionnaire for Coffee Growers

Information

1) Name:
2) Estate address:
3) Contact details:
4) Gender:
5) Apart from coffee any other occupation:
6) How old is the coffee estate?
7) Altitude of the coffee estate?
8) For how many generations have you been working with coffee estates?
9) How many acres is it?
10) What is the pH of the soil at your coffee estate and when did you last test it?
11) How much of it is used for coffee and what other crops are grown on the coffee estate?
12) What percentage of the total income comes from these additional crops?

Planting related questions

1) In a year how many new coffee saplings do you plant and how many old plants do you uproot? Are these numbers fixed?
2) How are the plants placed in your coffee estate? Or what is the design of your coffee estate? Why are you following this specific design in your coffee estate?
3) As the owner what planting related matters do you look at yourself and what do you leave upto the helping staff?
4) What is the trend at your coffee estate?
    a) Are you moving from Arabica to Robusta? If yes, why?
    b) Are you moving from Robusta to Arabica? If yes, why?
    c) Or has the % share remained the same?
5) What varieties have you been planting? Did you switch to any new variety at some point? If yes, then which one and why? Where do you procure your seeds from?
6) What is the major source of water for irrigation at the coffee estate: rainfall, tanks , groundwater or some other source?
7) Has there been any change in planting practices since liberalization like: new kind of pesticides or fertilizers, new varieties of Arabica and Robusta?
8) How do you manage shade? Which trees do you plant the most? Are there any trees that you plant for shade and timber both?

Weather and climate

1) What is the biggest risk factor for coffee estate and why?
2) What all weather related information do you collect at your coffee estate?
3) Based on your experience can you share any geographical uniqueness of your coffee estate?
4) When was the last time you experienced a drought situation? How do you define a drought condition?
5) Have you ever experienced loss of crop due to heavy winds?
6) Can you share rainfall records or temperature records from your coffee estate?
7) Have you witnessed fluctuation in rainfall pattern or temperature? Are you in anyway neutralizing these fluctuations through small changes in cultivation culture?, If yes, then what are these cultivation changes?

General

1) According to you what is the most serious problem being faced by coffee growers? Why do you rate this problem as the most difficult one to cope with. Is Coffee Board addressing this in anyway?
2) Are you aware that state government is giving 25% subsidy on RISC insurrance. So the growers will have to pay only 25% of the total premium amount (only in Karnataka) for Rainfall Insurance Scheme for Coffee.
3) What if private companies entre this market like ICICI Lombard or IFFCO Tokio. How will growers react to that in your opinion?

Questions about Everyday Activities on Estates

1) Which activity takes your maximum time at the coffee estate?
   Or
   Which coffee estate related activity do you devote your maximum time to?
2) Was this also the maximum time consuming activity in your father's and grandfather's generation?
3) What is the significance of this activity in the entire crop cycle? Or
   Why is this activity important?
4) Top three things on/ about the coffee estate which will immediately get your attention?
5) Things on/ about the coffee estate which you can afford to overlook or which do not require your immediate attention?
6) Do you visit your coffee estate everyday? Which part of the year or crop cycle are you definitely on the coffee estate everyday?
7) When do you plan your vacation or your time away from coffee estate?
8) What is your daily schedule on coffee estate?
9) Which coffee estate related events and activities do you plan in the beginning of the year?
10) Which activities are decided as per your immediate convenience and other factors?

Annexure 11

Survey Questionnaire used at the Black Gold League (BGL) Training Session

Anshu Ogra
PhD Candidate
Centre for Studies in Science Policy
Jawaharlal Nehru University

Date: 18/01/15
Place: Mudgere, Chickmaglur, Karnataka

Questionnaire

Thank you for agreeing to take part in this study. This field study is done as a part of my PhD project title *Science and situated knowledge: Coffee growers and adaptation strategies for climate change in South India* registered at Jawaharlal Nehru University, New Delhi. The information gathered through this field survey will be used only for academic purposes.

Q1. Name, postal address of the plantation and contact details.

Q2. What is the elevation of your plantation?

Q3. How much rainfall do you receive normally at your plantation?

Q4. When do you expect blossom showers?

Q5. Have you observed any change in the pattern of rainfall? How does this change affect your crop output and cultivation practices?

Q6. Do you have irrigation system at your plantation? If yes, then which year did you install it in and what is the source of water for irrigation: stream, water tank, borewell or someother source?

Q7. What do you grow more Arabica or Robusta?

Q8. What are the top three problems that you are facing at your plantation?

Q9. How, according to you, can government agencies help in addressing these problems?

Q10. From which source do you receive information about rainfall: TV, newspaper, radio, internet, the local calendar or some other source?

Q11. Do you subscribe to rainfall Insurance Scheme for Coffee Growers? If no, then why?

Q12. Do you maintain rainfall records? If possible can you please share a copy of the records.

Annexure 12

Questionnaire for Meteorologists, Climatologists and Climate Scientists

Name:

Designation:

Organization:

Contact details:

Area of specialization:

Meteorologists

Q1. At which scale do you engage with weather : macro, meso or micro?

Q2 Which models (weather and climate) have you worked on?

Q3 Which model are you currently working on ? What are the distinguishing features of this model?

Q4 What are the deliverables expected from your team or your institution?

Q5 How do these deliverables fit into the larger climate/ weather knowledge network?

Climatologists

Q1. How does climatology, being pursued at your institutions, informs weather forecasting?

Q2. What is the difference in monitoring weather at macro, meso and micro scale? What are the infrastructural differences in monitoring these scales?

Q3. In a way, what a reference weather station captures would reflect as local climate. How then are the reference weather stations positioned in terrains like Western Ghats where there is excessive variation observed on ground? Or

Q3. Location of local weather stations would be crucial exercise because in a way the data gathered from these stations filter space and time construction. How are they located, manned or monitored?

Q4. How frequently is data gathered from these collection points? How does frequency of data collection affect forecasting?

Q5. How is your organization located in the larger weather and climate infrastructure network of IMD?

Q6. How do you arrive at normal weather conditions for a particular place?

Q7. Time and space both are equally crucial aspect of scales at which weather is monitored. They are inextricably linked. If a climate fluctuation persists for a longer time it will invariably affect a larger area. Can you share something on the relationship or nature of these two dimensions in weather monitoring?

Q8. Does your work in any way inform climate science research or Do you receive any inputs from climate science?

Q9. Local climate as experienced everyday would be closer to micro climate measurements or meso-climatic measurements? How do you define local climate in scientific terms?

Climate Scientists

Q1. How are baseline simulations in climate science different from calculating normal for meteorological observations?

Q2. While making projections about future time period on a regional scale how do you account for spatial changes which will have significant impact on the then climate?

Q3.What are the problems in making long term projections on a finer resolution?

Annexure 13

Questionnaire for Insurers

Q1. How is Index Based Weather Insurance (IBWI) different from other crop insurance schemes?

Q2. What are the conditions for introducing IBWI scheme for a crop?

Q3. How was it realized that insuring rainfall will help coffee growers?

Q4. How did you identify the rain- gauge network that best captures rainfall on the ground?

Q5. Can you share the statistical methods which help you to arrive at the trigger levels of the payout?

Q6. How often are the rainfall trigger levels, premium and payouts revised?

Q7. Which other organizations help you in bringing this scheme together?

Q8. The scheme is not doing particularly well. What are the reasons according to you?

Q9. Are there any plans to improve the scheme in a way that it becomes attractive for growers?

Q10. What is the future of RISC?

Annexure 14

Coffee Data

Production of Coffee in India since 1950-51

Data Source: Coffee Board Database (*http://www.indiacoffee.org/database-coffee.html*)

Year	Arabica	%	Robusta	%	Total
1950-1951	15511	82	3382	18	18893
1960-1961	39526	58	28643	42	68169
1970-1971	58348	53	51883	47	110231
1980-1981	61262	52	57384	48	118646
1990-1991	78311	46	91415	54	169726
1991-1992	88320	49	91680	51	180000
1992-1993	73120	43	96275	57	169395
1993-1994	98300	46	113700	54	212000
1994-1995	79000	44	101100	56	180100
1995-1996	103250	46	119750	54	223000
1996-1997	90450	44	114550	56	205000
1997-1998	99300	43	129000	57	228300
1998-1999	97000	37	168000	63	265000
1999-2000	119000	41	173000	59	292000
2000-2001	104400	35	196800	65	301200
2001-2002	121050	40	179550	60	300600
2002-2003	102125	37	173150	63	275275
2003-2004	101950	38	168550	62	270500
2004-2005	103400	38	172100	62	275500
2005-2006	94000	34	180000	66	274000
2006-2007	99700	35	188300	65	288000
2007-2008	92500	35	169500	65	262000
2008-2009	79500	30	182800	70	262300
2009-2010	94600	33	195000	67	289600
2010-2011	94140	31	207860	69	302000
2011-2012	101500	32	212500	68	314000
2012-2013	98600	31	219600	69	318200
2013-2014	102200	34	202300	66	304500
2014-2015	98000	30	229000	70	327000
2015-2016	103500	30	244500	70	348000
2016-2017	96200	30	220500	70	316700

Coffee Production by states

S.no	State	Arabica (MT)	%	Robusta (MT)	%	Total (MT)	%to India
1.	Karnataka	78650	22.6	172870	49.7	251520	72.3
2.	Kerala	2200	0.6	67030	19.3	69230	19.9
3.	Tamil Nadu	12810	3.7	4485	1.3	17295	5.0
	Total for Traditional Areas	93660	26.9	244385	70.2	338045	97.1
4.	Non Traditional Areas	9750	2.8	50	0.0	9800	2.8
5.	North Eastern Region	90	0.0	65	0.0	155	0.0
	Total (India)	103500	29.7	244500	70.3	348000	100.0

Number, Area and Share of Production of Coffee under different sizes of coffee holdings in India 2007-2008

S.no.	Size of holdings (in hectares)	No. of holdings		Area under coffee		Share of production
		Number	% to total	Area (in ha)	% to total	
1.	Small holdings					
	< 2	178585	80.9	144196	37.1	
	2-4	27731	12.6	71905	18.5	
	4-10	11800	5.3	73642	19.0	
	Sub total	218116	98.8	289743	74.6	70%
2.	Large holdings					
	10-25	1789	0.8	29829	7.7	
	>25	920	0.4	68623	17.7	
	Sub total	2709	1.2	98452	25.4	30%
3.	Total (India)	220825	100.0	388195	100.0	100%

Bearing Area, Coffee Production and Productivity -2017-2018

State/District	Bearing Area			Production (MT)			Productivity (Kg/ha)		
	Arabica	Robusta	Total	Arabica	Robusta	Total	Arabica	Robusta	Total
Chikmaglur	49251	38212	87463	31,600	43,275	74875	642	1,132	856
Kodagu	26889	75174	102063	19,550	97000	116550	727	1,290	1,142
Hassan	23557	13161	36718	17,875	13,000	30875	759	988	841
Karnataka	99697	126547	226244	69025	153275	222300	692	1,211	983
Kerala	3955	81021	84976	2160	63575	65735	546	785	774
Tamil Nadu	27800	5813	33613	13400	4040	17440	482	695	519

Distribution of interviewed coffee growers according to the size of their land holdings

Number of Growers interviewed with land holdings over 25 ha (very large growers)	Number of Growers interviewed with land holdings between 10-25ha (large growers)	Number of Growers interviewed with land holdings between 2-10 ha (small growers)	Number of Growers interviewed with land holdings less than 2 ha (very small growers)
5	25	27	25
Total number of growers interviewed – 82			

Annexure 15

Rainfall Stories from Coffee Estates

Did it rain on your side of the fence?[1]

The other day I ran into my friend John the coffee planter. He was standing near his estate gate with his face turned up, looking anxiously at the sky or something.

I stopped the car. It had been some time since I had seen him. I said, 'Hi!'

He recognized my car, so he knew who I was before I got out. He waved back rather cheerfully. He noticed the drops of water on my windshield. It had drizzled a bit a couple of miles back. 'You got rain on the way?' he asked.

'Yes', I said, 'When I was passing Irrikolli.'

Irrikoli Estate belonged to John's cousin Don. His face fell instantly. 'That fellow is always lucky', he said.

'No rain here?' I asked. I knew the answer even before he answered.

'No', his face became even longer.

I tried to make him feel better. 'Don's estate is in blossom. It's not good to have rains on open blossom', I said.

He cheered up instantly. 'I hope it doesn't ruin his crop', he said, not meaning a word of it.

As I drove away, I saw him in the rear view mirror, peering upwards at the heavy clouds that had bought rains just two miles away, but not to him.

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[1] MA Deviah.(2008). Did It Rain On Your Side of the Fence?. *Memories and Musings:50 years of KPA*. Bangalore: Kumaran Printers: 99-100.

Put two planters and a couple of pegs of whisky together and you can be sure that the conversation will invariably turn to the weather. It's too hot, or too cold, too dry or too wet. The Lord God can put out as many versions of the weather as he can, but there will never be anything that satisfies a coffee planter.

Once, I was sitting with a planter on his verandah, as he gloomily watched it rain like crazy across the valley. Sheets of water were coming down like monsoon charged waterfall. But the rain stopped just short of his fence. Not a drop on his side of the valley. My heart went out to him.

Later that evening at the club, I met his neighbor who had benefitted from weather God's largesse. He was seated in front of a large whiskey and soda. 'Good rain today', I said cheerfully, hoping his happiness would lead to him buying me a couple.

He looked up. But he was almost in tears. He said, 'I applied urea just this morning. Now it's all washed away. I wish it had rained tomorrow'.

Like I said, the gods never get it right.

Be Not the Red Indian[2]

One autumn just before the onset of winter, Red Indians from a certain tribe asked their new Chief if the winter was going to be cold or mild. Since the Chief had graduated from a collage, he was not aware how to predict the weather. Nevertheless to be on the safe side, he tells his tribe that the winter was indeed going to be cold and they should collect wood to be prepared.

[2] M Cariappa Appaiah .(2008). Be Not The Red Indian. *Memories and Musings:50 years of KPA.* Bangalore: Kumaran Printers, 2008:32

At the same time the chief plays it smart and calls up National Weather Service and asks ‘Is the winter going to be cold?’ The weather man replies that it is going to be a very cold winter. So the chief asks his people to collect even more wood.

A week later he checks with the weather man once again ‘Is it going to be a very cold winter?’ The weather man replies that it is going to be a very cold winter. So the Chief asks his people to collect every possible bit of wood. One more week later chief calls the weather man for the third time. ‘Are you absolutely sure the winter is going to be very cold?’

‘Absolutely,’ replies the weather man.

‘How can you be so sure?’ The Chief asks.

The weather man replies: ‘The red Indians are collecting wood like crazy.’

Generally this is how coffee plantation and weather forecasts work.

Annexure 16

About Central Coffee Research Institute (CCRI)

Coffee science research is carried out at Central Coffee Research Institute (CCRI) which was established as coffee experimental farm in 1925, in Balehonnur on 17 acres of Guntanaik Estate gifted to the project by Crawford brothers. However, the first scientific adviser, Dr. Lehman, was appointed by Mysore Government in 1899 much before the genesis of the Institute. The need for scientific intervention in Indian coffee plantations arose from the threat posed by a fungal disease called leaf rust (*Hemileia vastatrix*). It wiped out coffee plantations in Sri Lanka in the late twentieth century. The attack of this disease was so severe that it single handedly reshaped the plantation landscape of Sri Lanka and the Travancore region in late nineteenth century.

The primary objective of the station during its establishment was to breed leaf resistant coffee varieties and to find remedies for the pest White Stem Borer. In 1946, Coffee board of India took over the research station from the government of Mysore. Today CCRI is located on a 13 hectare land comprising of housing facilities, laboratories, research farm, training center and other infrastructural facilities. In addition to main station there is a substation at Chettali Kodagu Karnataka and four Regional Coffee Research Stations one each at Chundale (Kerela), Thandigudi (Tamil Nadu), Raghavendra Nagar (Andhra Pradesh) and Diphu (Assam). It is located in Balehonnur, Chikmaglur and is approximately 295 Kms from Bengaluru

In addition to these, CCRI has one well equipped Tissue culture and Bio-Technology Centre at Mysore, Analytical Laboratory and Quality Evaluation Centres functioning at Bengaluru, Chikmaglur and Kodagu. In addition to this there are 9 Coffee Demonstration Farms (CDF) and an extension wing which functions under the research department. The extension units are located in all the major coffee growing zones with strength of 278 personnel. It carries out research in the disciplines of plant breeding and genetics, coffee agronomy, soil science and agricultural chemistry, plant physiology, plant pathology, entomology, post-harvest technology, coffee biotechnology and coffee quality. CCRI therefore evolved from the need for scientific intervention realized by growers.

Annexure 17

Local Calendar or the Luni-Solar Calendar

The luni-solar calendar also referred to as the Hindu calendar, as I was given to understand, constitutes a significant form of knowledge about weather behavior. Usage of the luni-solar calendar, however, is not specific to the coffee growers only. Apparently, it continues to be in wide use for various purposes (secular and religious) throughout kannadiga society. In particular, by castes such as the *Gowds* and the *Lingayats* and also by the local Muslim communities, to some extent. All the growers whom I interviewed used what they refer to as the Bangalore Press Calendar, which is designed as a hybrid of sorts carrying the luni-solar dating schema alongside the standard Gregorian calendar[1] (which is the solar calendar). In particular, the Bangalore Press Calendar carries the dates and time of the commencement of the *Malay Nakstra*.[2] Shiv Shankar, a coffee grower in Chikmaglur, during my interview, explained this seemingly confusing arrangement in detail:

> Luni-solar calendar has 27 months. Each malay nashtra is named after the month in which it falls. These are: *Revathi, Ashvini, Bharani, Krittika, Rohini, Mrigshirsha, Ardra, Punarvasu, Pushya, Aslesha, Magha, Purva Phaluguni, Uttra Phalguni, hasta, Chitra, Swati, Vishakha, Anuradha, Jyeshtha, Mula, Purva Ashadha, Uttra Ashadha, Shravana, Dhanishta,*

[1] The Gregorian calendar, also called the Western calendar and the Christian calendar, is the internationally accepted secular calendar.

[2] Nakstras defines the position of moon in its orbit around the earth. *Malay Nakstra* describes the kind of rainfall depending upon the specific time of the year: heavy and continuous rainfall , sporadic showers or winter drizzle. Bangalore Press Calendar carries out the exercise of determining the time for the commencement of these nakshtra and forecasts the expected time of the rainfall. This calendar is not, however, designed to indicate abrupt weather changes or events.

Shatabhisha, Purva Bhadrapada, Uttara Bhadrapada. There exists a 15 day gap between two consecutive nakshtras.[3]

Ravi Shankar, Shiv Shankar's younger brother and an engineer by profession, settled with his family in Bengaluru, is also typical of some of the growers who visit their estates once in a fortnight. Just like his other brothers, he also inherited about 40 acres of his estate. For Ravi Shankar, the luni-solar calendar informed several cultural practices such as festivals and religious events as well and was therefore more than simply an information source about rainfall. The Ugadi, a local festival, for example, marked the beginning of the New Year for communities in the region and its date was decided by the luni-solar calendar. By the Gregorian calendar this festival falls in the last week of March or first week of April tentatively.

The information about the Malay pattern (rainfall pattern) for the coming year is published in the Panchang on day of the Ugadi. The readings and assessments of the Panchang are then translated and transposed onto the Gregorian calendar, which is then printed as the Banglore Press calendar. Revathi Malay or blossom shower coincides most often than not with the 31st March in the Gregorian calendar. The monsoon rainfall, on the other hand, is to be read from the Mrigshrisha onwards, which most often coincides with 8th June, according to the Gregorian calendar. Technically from Jyeshtha till Dhanishtha there should be no rainfall. This is the period between 3rd of December – 15th of February on the Gregorian calendar. On being asked, if rainfall still follows this pattern, Shiv Shanker replied 'Nakshtras are to follow rainfall and not vice versa.'[4]

S.M. Somesh, who could converse only in kannada, is a first generation coffee grower. He bought the coffee estate on his own and appeared to be a confident self-made

[3] Shiv Shankar's interview taken on 11th December 2011 at his Balagola Estate, near Badra Forest in Chikmaglur district.

[4] Shiv Shankar's recorded interview.

man. He now owns about 50 acres of land and grows only Arabica. Through a grower, who was translating our conversation, I was told that he follows only the malay nakshtra for weather Forecasting. He was aware that rainfall pattern is not exactly the same as earlier but comparatively he has less experience of weather vagaries because 'God has been really gracious. We get rain as and when they are expected.'[5] Although the luni-solar calendar is framed very much as seemingly Hindu idioms and metaphors, it is overwhelmingly considered to be a part of local cultures. Muslim growers, it appeared to me, are fairly familiar with and attuned to its cycles and notions of time and dates. Khallel Mahmood, having 10 acres of land near Aranhalli, considered the Revathi Malay (blossom shower) as being central to determining the entire year's working routines.[6]

For the CCRI, however, information about the weather and all meteorological forecastings, are based on the Gregorian calendar which is based on the motion of the sun and ignores the Moon. According to solar calendar a solar year is the time period of the successive return of the sun to the same reference point on the ecliptic.[7] This is also known as the tropical solar year. Luni-solar calendar, on the other hand, uses lunar months[8] to approximate a solar year. In luni-solar year, the solar year measured is the actual time taken for the earth to revolve around the sun with respect to a fixed star. This is also known as a sidereal solar year. Because the lunisolar calendar uses lunar months to approximate a solar year, it is about 11 days shorter then solar year used in the Gregorian

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[5] S.M.Somesh's interview taken on 22nd December 2012 at Ballupet Planters' Association office, Ballupet, Sakleshpura. He responded in Kannada which was simultaneously translated into English by B.M.Jagannath.

[6] B.I. Khaleel Mahmood's interview taken on 21st December 2011 at Arrehalli Planters Association office.

[7] Ecliptic refers to the plane of the elliptical orbit traversed be earth while revolving around the sun.

[8] A lunar month is the time interval between two successive full moons.

calendar. A leap month is inserted about every third year to keep the calendar in tune with the seasons.[9]

Most growers seems to follow a dual strategy in the ways they respond to weather forecasts. The immediate everyday working (such as manuring, gleaning, shade regulation, weeding etc.) on coffee plantations are based mostly on the Gregorian calendar, whereas planning for an entire year (such as planting new saplings, harvesting) is done on the basis of the traditional luni-solar calendar. This distinction is not rigidly marked. At times both calendars are referred simultaneously.

[9] Chia Daphne, *Indian Calendars : Comparing the surya sinddhanta and the astronomical ephemeris* (University of Singapore, 2000-01), http://www.math.nus.edu.sg/aslaksen/projects/dc-urops.pdf (accessed on 5th May 2012).

Annexure 18

List of Reference Rain Gauge (RRG) Network used for Rainfall Insurance Scheme for Coffee (RISC)

Source: RISC Document, 2014. Document obtained from AIC office, Bangalore

Agriculture Insurance Company of India Ltd,
Regional Office: Bangalore

Annexure - I

RISC 2015 - List of Notified Reference RainGauge Stations (RRG) & Back up Rain Gauge Stations (BRG) with Location Details

S.No	Zone	Sub-zone	Reference Station	Location	Back up station	Location
CHICKMAGALUR						
1	Aldur	Aldur	KSNDMC TRG - Aldur	Premises of Inspection bungalow	KSNDMC TRG - Mudigere	Premises of Inspection bungalow
2	Aldur	Elekhan	NCMSL AWS - Elekhan	Sri.S.Mukthiar Ahmed, GoldenEarth estate, Elekhan village, Aldur Post-577111 Chikmagalur Dt.	KSNDMC TRG - Aldur	Premises of Inspection bungalow
3	Balehonnur	Balehonnur	NCMSL AWS - Balehonnur	CCRI Campus	KSNDMC TRG - Balehonnur	Premises of Seed Production Centre
4	Chikmagalur	Chikmagalur	NCMSL AWS - Joldal	Mr. J L Krishna Gouda,Joldal Estate, Chikmagalur (Tk)-577130	KSNDMC TRG - Vasthare	Premises of Govt.Hospital
5	Giris	Giris	NCMSL AWS - Giris	Mr. K Srinivasa Rao, Ramgiri Coffee Estate, Bisagnimutte Mahal (PO), Chikmanglur-577131	NCMSL AWS - Joldal	Mr. J L Krishna Gouda, Joldal Estate, Chikmagalur (Tk), Chikmagalur-577130
6	Gonibeedu	Devarunda	NCMSL AWS - Devarunda	Sri.H.B.Chandregowda, S/o Byregowda, Chandrika Estate, Koodurasthe, Devarunda-577151, Chikmagalur Dt.	NCMSL AWS - Devaladakere	Mr D Aswath, Choudigudi Estates, Devalakere (Po),Hanbal, Sakaleshapur (Tk), Hasan-577119
7	Gonibeedu	Gonibeedu	KSNDMC TRG - Gonibeedu	Premises of Grama Panchayat Office	KSNDMC TRG - Mudigere	Premises of Inspection bungalow
8	Kalasa	Balehole	NCMSL AWS - Balehole	Mr. Pradeep Kumar B,P.B.NO-3, Bantaganahalli, Mudigree (Tk), Ballehole-577179	KSNDMC TRG - Balehonnur	Premises of Seed Production Centre
9	Kalasa	Hirebyle	NCMSL AWS - Hirebyle	Mr. Rajkumar Wilson, JOONKTOLLE teak industries ltd, Goomankhan Estates, Hirebele (PO), Chikmagalur-577121	KSNDMC TRG - Javali	Premises of Grama Panchayath office
10	Kalasa	Javali	KSNDMC TRG - Javali	Premises of Grama Panchayat Office	KSNDMC TRG - Idakani	Grama Panchayat office, Hirebail
11	Kalasa	Kalasa	KSNDMC TRG - Kalasa	Premises of Govt.Hospital	KSNDMC TRG - Javali	Premises of Grama Panchayat
12	Kalasa	Niduvale	NCMSL AWS - Niduvale	Mr. U K Laxman Gouda, Urvinkhan Estate, Niduvale (Vill & Po), Mudigere (Tk), Chikkamagalur-577122	KSNDMC TRG - Banakal	Grama Panchayat office, Banakal
13	Koppa	Jayapura	KSNDMC TRG - Megunda	Premises of Inspection Bungalow	KSNDMC TRG - Balehonnur	Premises of Seed Production Centre
14	Koppa	Koppa	KSNDMC TRG - Koppa	Premises of PWD Office	KSNDMC TRG - Hariharpura	Premises of Grama Panchayat
15	Koppa	N.R.Pura	KSNDMC TRG - N.R.Pura	Premises of Inspection Bungalow	KSNDMC TRG - Balehonnur	Premises of Seed Production Centre
16	Koppa	Sringeri	KSNDMC TRG - Sringeri	Premises of Inspection bungalow	KSNDMC TRG - Jayapura	Premises of Inspection bungalow
17	Mallandur	Bogase	NCMSL AWS - Bogase	Sri Krishna Shetty, Bogase (vill & Po)-577130. Chikmagalur Dt	KSNDMC TRG - Sangameshvarapet	Premises of Forest office Dept
18	Mallandur	Mallandur	NCMSL AWS - Mallandur	Mr. Ramesh Kumar M E, I G Road, Chickmagalur. Pin: 577 101	NCMSL AWS - Joldal	Mr. J L Krishna Gouda, Joldal Estate, Chikmagalur (Tk), Chikmagalur Dt -577130
19	Mudigere	Hosakere	NCMSL AWS - Hosakere	Mr.H.S.Sundaresh, Husakere (Vill), Urubage (Po), Mudigere (Tk), Chickmagalur Dist.	KSNDMC TRG - Mudigere	Premises of Taluk Office
20	Mudigere	Mudigere	KSNDMC TRG - Mudigere	Premises of Inspection bungalow	KSNDMC TRG - Gonibeedu	Premises of Grama Panchayat Office
Hassan						
21	Belur	Belur	NCMSL AWS - Arehally	Mr. U M Tejpal, Arahalli Main Road, Arahalli (PO), Belur, Hasan-573101	KSNDMC TRG - Biccodu	Premises of the Govt.Boys General Hostel
22	Belur	Biccodu	KSNDMC TRG - Biccodu	Premises of the Govt. Boys General Hostel	NCMSL AWS - Arehalli	Mr. U M Tejpal, Arahalli Main Road, Arahalli (Po), Belur, Hasan-573101
23	Hanbal	Hanbal	NCMSL AWS - Devaladakere	Mr D Aswath, Choudigudi Estates, Devalakere (PO), Hanbal (Tk), Sakaleshapura, Hasan - 577119	KSNDMC TRG - Hanbal	Gram Pancyayat Office
24	Hanbal	Maranahalli	NCMSL AWS - Maranahalli	Mr. John P Puthurmana, Nettally Estate, Heggadde(PO), Sakleshpur, Hassan-57 3145	NCMSL AWS - Devaladakere	Mr D Aswath, Choudigudi Estates, Devalakere (Po), Hanbal (Tk), Sakaleshapura, Hasan-577119
25	RK Magge	Halliyur	NCMSL AWS - Halliyur	Mr. K C Poovaiah, Halliyur (Village), Malagalale (PO), K Hoskate (VIA),Alur (Tk), Hassan-573129	KSNDMC TRG - K.Hosakote	Premises of Primary Health centre
26	RK Magge	K.Hosakote	KSNDMC TRG - K.Hosakote	Premises of Primary Health centre	NCMSL AWS - Halliyur	Mr. K C Poovaiah, Halliyur (Vill), Malagalale (Po), K Hoskate (Via), Alur (Tk), Hassan-573129
27	RK Magge	RK Magge	KSNDMC TRG - Kundur	Premises of Samudaya Bhavan	KSNDMC TRG - K Hosakote	Premises of Primary Health centre
28	Sakaleshpur	Ballupet	KSNDMC TRG - Belagodu	Premises of Govt High School	KSNDMC TRG - Sakaleshpur	Premises of Inspection Bunglow office
29	Sakleshpura	Sakleshpura	KSNDMC TRG - Sakleshpur	Premises of Inspection Bungalow Office	KSNDMC TRG - Belagodu	Premises of Govt High School
30	Yeslur	Hethur	KSNDMC TRG - Hethur	Grama Panchayat Office, Hethur (vill & Po)- 573137 Sakleshpur Taluk, Hassan Dist.	NCMSL AWS – Uchangi	Mr. S R Kumar, Uchangi (Vill & Po), Sakleshpur (Tk), Hassan-573137

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Agriculture Insurance Company of India Ltd,
Regional Office: Bangalore

Annexure - 1

RISC 2015 - List of Notified Reference RainGauge Stations (RRG) & Back up Rain Gauge Stations (BRG) with Location Details

S.No	Zone	Sub-zone	Reference Station	Location	Back up station	Location
31	Yeslur	Uchangi	NCMSL AWS - Uchangi	Mr. S R Kumar, S/o late U R Srekhanthaya, Uchangi (Vill & Po), Sakleshpur (Tk), Hassan-573137	KSNDMC TRG - Yeslur	Premises of Primary Health centre
32	Yeslur	Yeslur	KSNDMC TRG - Yeslur	Premises of Primary Health centre	NCMSL AWS - Uchangi	Mr. S R Kumar, Uchangi (Vill & Po), Sakleshpur (Tk), Hassan-573137
KODAGU						
33	Gonikoppal	Gonikoppal	KSNDMC TRG - Ponnampet	Premises of Agricultural Research Centre	KSNDMC TRG - Devamachi	Gram Panchayat Office
34	Gonikoppal	Thithimathi	NCMSL AWS - Thithimathi	Mr. Bheemaiah T M, Tata coffe ltd, Balmany Estate, THITHIMATHI (PO), Virajpet (Tk), Coorg -571254	KSNDMC TRG - Ponnampet	Premises of Agricultural Research Centre
35	Madikeri	Madikeri	KSNDMC TRG - Madikeri	Premises of Inspection Bungalow	KSNDMC TRG - Napoklu	Premises of Inspection bungalow
36	Madikeri	Makkandur	NCMSL AWS - Makkandur	Mr. M S Monnappa, Udayanivar[Chinnikoppa Estate], Makkandur(Vill & Po), Mdikeri, North Kodagu -5712201	KSNDMC TRG - Madikeri	Premises of Inspection Bungalow
37	Madikeri	Murnad	NCMSL AWS - Murnad	Mr.Baduvanda A Chinnappa, Sharadanivan, Opp JuniorCollege, Murnad (Po), Madikeri(Tk), Dist-North Kodagu-571252	KSNDMC TRG - Madikeri	Premises of Inspection Bungalow
38	Napoklu	Cherambane	NCMSL AWS - Cherambane	Mr.Ramakrishna, Charambane (PO), Madikeri (Tk), Kodagu Dist.	KSNDMC TRG - Napoklu	Premises of Inspection bungalow
39	Napoklu	Karada	NCMSL AWS - Karada	Mr. B P Subbaiar, Karada (Vill &Po), Mudikeri (TALUKA), North Kodagu -571212	KSNDMC TRG - Virajpet	Premises of veterinary Hospital
40	Napoklu	Napoklu	NCMSL AWS - Napoklu	Mr. A C Appayya,C/o.Naresh.P.J. Pallicad Estate, Kakabbe Post Dist-South Kodagu,,5 7 1 2 1 2,Karnataka.	KSNDMC TRG - Napoklu	Premises of Inspection bungalow
41	Shanivarsanthe	Arkanhalli	KSNDMC TRG - Kodlipet	Premises of Primary Health Hospital	KSNDMC TRG - Sanivarsanthe	Premises of Inspection bungalow
42	Shanivarsanthe	Shanivarsanthe	KSNDMC TRG - Sanivarsanthe	Premises of Inspection bungalow	KSNDMC TRG - Yeslur	Premises of Primary Health centre
43	Siddapur	Ammathi	KSNDMC TRG - Ammathi	Premises of Revenue Dept.	KSNDMC TRG - Virajpet	Premises of veterinary Hospital
44	Siddapur	Maldare	NCMSL AWS - Maldare	Premises of Grama Panchayat Office	KSNDMC TRG - Virajpet	Premises of veterinary Hospital
45	Siddapur	Siddapur	NCMSL AWS - Siddapur	JLO Coffeeboard, Polibetta Road, South Kodagu-571253	KSNDMC TRG - Ammathi	Premises of Revenue Dept.
46	Somwarpet	Abburkatte	NCMSL AWS - Abburkatte	Shri. T.S. PRAKASH, Abbrukatte (Vill & Po), Somwarpet (Tk), Kodagu-571236	KSNDMC TRG - Somwarpet	Premises of Inspection bungalow
47	Somwarpet	Basavanahalli	NCMSL AWS - Basavanahalli	Mr. B S Shivshankar, Belur Estate(Po), Somwarpet, North Kodagu-571236	KSNDMC TRG - Sunticoppa	Premises of Nadakacheri
48	Somwarpet	Hanacodu	NCMSL AWS - Hanacodu	Mr. S Dayananda, Gajjenkode(Village), Hancode(Po), Somwarpet (Tk), Dist-North Kodagu-571236	KSNDMC TRG - Somwarpet	Premises of Inspection bungalow
49	Somwarpet	Shanthalli	KSNDMC TRG - Shanthalli	Premises of Govt.Hospital	KSNDMC TRG - Somwarpet	Premises of Inspection bungalow
50	Somwarpet	Somwarpet	KSNDMC TRG - Somwarpet	Premises of Inspection bungalow	KSNDMC TRG - Shanthalli	Premises of Govt.Hospital
51	Srimangala	Nagarahole	NCMSL AWS - Nagarahole	Sri.K G Chethan, MGM COMPLEX, Near Canara Bank, Kutta-571250, South Kodagu.	KSNDMC TRG - Balele	Premises of Govt.Hospital
52	Srimangala	Srimangala	KSNDMC TRG - Srimangala	Premises of Inspection bungalow	KSNDMC TRG - Devamachi	Gram Panchayat Office
53	Srimangala	Vatekolli	NCMSL AWS - Vatekolli	Mr. Aiyyappa K A, V S S N Bank, Birunani (Vill & Po), Virajpet (TQ), Coorg -571249	KSNDMC TRG - Balele	Premises of Govt.Hospital
54	Sunticoppa	Chettalli	CRSS – AWS – Chettalli	Premises of CRSS	KSNDMC TRG - Madikeri	Premises of Inspection Bungalow
55	Sunticoppa	Garvale	NCMSL AWS - Garvale	Sri.I.K Girish, Garvale (Vill & Po), Somwarpet (Tk), Kodagu Dist.	KSNDMC TRG - Shanthalli	Premises of Govt.Hospital
56	Sunticoppa	Madapura	NCMSL AWS - Madapura	Mr. Santosh Mohan,CoumburEstates, Madapur,P.B.No-01,somavarapet (Tk),Dist-Kodagu,571251	KSNDMC TRG - Somwarpet	Premises of Inspection bungalow
57	Sunticoppa	Sunticoppa	KSNDMC TRG - Sunticoppa	Premises of Nadakacheri	KSNDMC TRG - Madikeri	Premises of Inspection Bungalow
58	Sunticoppa	Valnoor	NCMSL AWS - Valnoor	Grama Panchayat Office, Valnoor -571234, Kushalanagar (Via), Somwarpet (Tk), Kodagu Dist.	KSNDMC TRG - Sunticoppa	Premises of Nadakacheri
59	Virajpet	B. Shettigeri	NCMSL AWS - B. Shettigeri	Village Panchayat Office, B.Shettigeri (Vill & Po), Virajpet (Tk), South Kodagu.	NCMSL AWS - Vatekolli	Mr. Aiyyappa K A, VSSN Bank, Birunani (Vill & Po), Virajpet (TQ), Coorg -571249
60	Virajpet	Virajpet	KSNDMC TRG - Virajpet	Premises of veterinary Hospital	KSNDMC TRG - Napoklu	Premises of Inspection bungalow

Annexure 19

Article Published in *Krushika* Magazine

Cover page of the issue

Article

Problems faced by Coffee Growers
due to Climate variation: a research enquiry

Climate change is most challenging environmental problem which agriculturalists are facing today. However, discussions on climate change are informed by scientists who make climate projections for unforeseeable future like climatic conditions in the year 2050. But how is this information relevant to a common agriculturalist? Or how do we understand the everyday problems of a common agriculturalist arising due to climate change.

This Ph.D. research focuses on South Indian coffee growers' community to document the problems they are facing due to change in rainfall pattern. This PhD work is based on My M.Phil. study titled 'Like I said, gods never get it right': Weather experiences, Weather Forecasting and Coffee Growers in Contemporary South India which was submitted in 2012 at Centre for Studies in Science Policy Jawaharlal Nehru University, New Delhi. The Mphil work highlighted that coffee growers' experience of fluctuation in rainfall is not sufficiently reflected in the scientifically defined "successful" or "failed" rainfall. For example net crop loss can occur due to untimely blossoming initiated by sporadic rains during the dry months of November and December even if revathi comes on time and delivers as per expectations. These and many other such subtle changes in rainfall which have serious implications for coffee growers escape from the scientific calculations and measurements.

The M.phil. work was received very well in the academic as well as policy circles. Now it has evolved into an ongoing Ph.D. titled Science and Situated Knowledge: Coffee growers and adaptation strategies for climate change in South India .

Coffee growers have been specifically chosen for this study because unlike any other plantation group coffee growers maintain detailed rainfall records. Hence, their experiences of fluctuation in rainfall can be supported with the detailed records that they have maintained. This study is carried out to inform policy makers for drafting more relevant and useful strategies which will help coffee growers in adapting to changing rainfall patterns.

This study requires interactions with as many coffee growers as possible. So far around 4 months have been spent travelling in the coffee growing belt and over 60 growers have been interviewed since 2011. The areas visited in Karnataka state include: Sakleshpur, Mudgere, Chickmaglur, Somarpet (Chettali) and Virajpet (Gonicoppa). Additionally growers in Pailini hill region in Tamil Nadu have also been interviewed.

It is for the first time that a study is being pursued which explores local experiences of weather variation to inform the policy makers in drafting adaptation strategies. This work will benefit immensely as more and more growers share their experiences however travelling to all the plantations is not physically possible. Therefore, I request the respected coffee growers reading this article to kindly share their response to few selected questions mentioned below.

ಬೆಳೆಗಾರರ ಬೆಳವಣಿಗೆಗೆ ಭರವಸೆ ನೀಡಬಹುದು ಮುಂದೆ.

ಹವಾಮಾನ ವೈಪರೀತ್ಯದಿಂದ ಕಾಫಿ ತೋಟಗಳು ಮತ್ತು ಕಾಫಿ ಬೆಳೆಗಾರರ ಮೇಲೆ ಆಗುತ್ತಿರುವ ಪರಿಣಾಮಗಳು ಮತ್ತು ಪರಿಹಾರಗಳ ಬಗ್ಗೆ ಒಂದು ಅಧ್ಯಯನವನ್ನು ದೆಹಲಿ ಮೂಲದ ಜವಾಹಾರ್‌ಲಾಲ್ ವಿಶ್ವ ವಿದ್ಯಾನಿಲಯದ ವಿದ್ಯಾರ್ಥಿ ಕು॥ ಅಂಶು ಆಗ್ರ ಅವರು ಮಾಡುತ್ತಿದ್ದಾರೆ. ಅದಕ್ಕಾಗಿ ಕೃಷಿಕ ಪತ್ರಿಕೆಯೊಡನೆ 2 ವರ್ಷಗಳಿಂದ ಸಂಪರ್ಕವಿಟ್ಟುಕೊಂಡು ಮಾಹಿತಿ ಕಲೆಹಾಕಿದ್ದಾರೆ. ಈ ಅಂಕಣದಲ್ಲಿ ವಿವರಗಳಿದ್ದು ಬೆಳೆಗಾರರಿಂದ ಮಾಹಿತಿಯನ್ನ ಕೋರಿದ್ದಾರೆ ಇದೊಂದು ಉತ್ತಮ ಬೆಳವಣಿಗೆ ಇಂತಹ ದಾಖಲಾತಿಗಳು ಮುಂದಿನ ದಿನಗಳಲ್ಲಿ ಬಹಳ ಉಪಯುಕ್ತವಾಗಲಿದೆ, ಆದ್ದರಿಂದ ಈ ನಿಟ್ಟಿನಲ್ಲಿ ಬೆಳೆಗಾರರ ಮಾಹಿತಿಗಳು ಬಹುಮುಖ್ಯ ಪಾತ್ರವಹಿಸುತ್ತವೆ.

Anshu Ogra:
(Ph.D. Scholar Centre for Studies in Science Policy, Jawaharlal Nehru University, New Delhi)

1. Name, postal address of the plantation, contact details.
2. How much rainfall do you receive normally at your plantation?
3. Have you observed any change in the pattern of rainfall? How does this change affect your crop output and cultivation practices?
4. What do you grow more Arabica or Robusta?
5. What are the top three problems that you are facing at your plantation?
6. How, according to you, can government agencies help in addressing these problems?
7. From which source do you receive information about rainfall: TV, newspaper, radio, internet, the local calendar or some other source?
8. Do you subscribe to rainfall Insurance Scheme for Coffee Growers? If no, then why?
9. Do you maintain rainfall records? If possible can you please share a copy of the records.

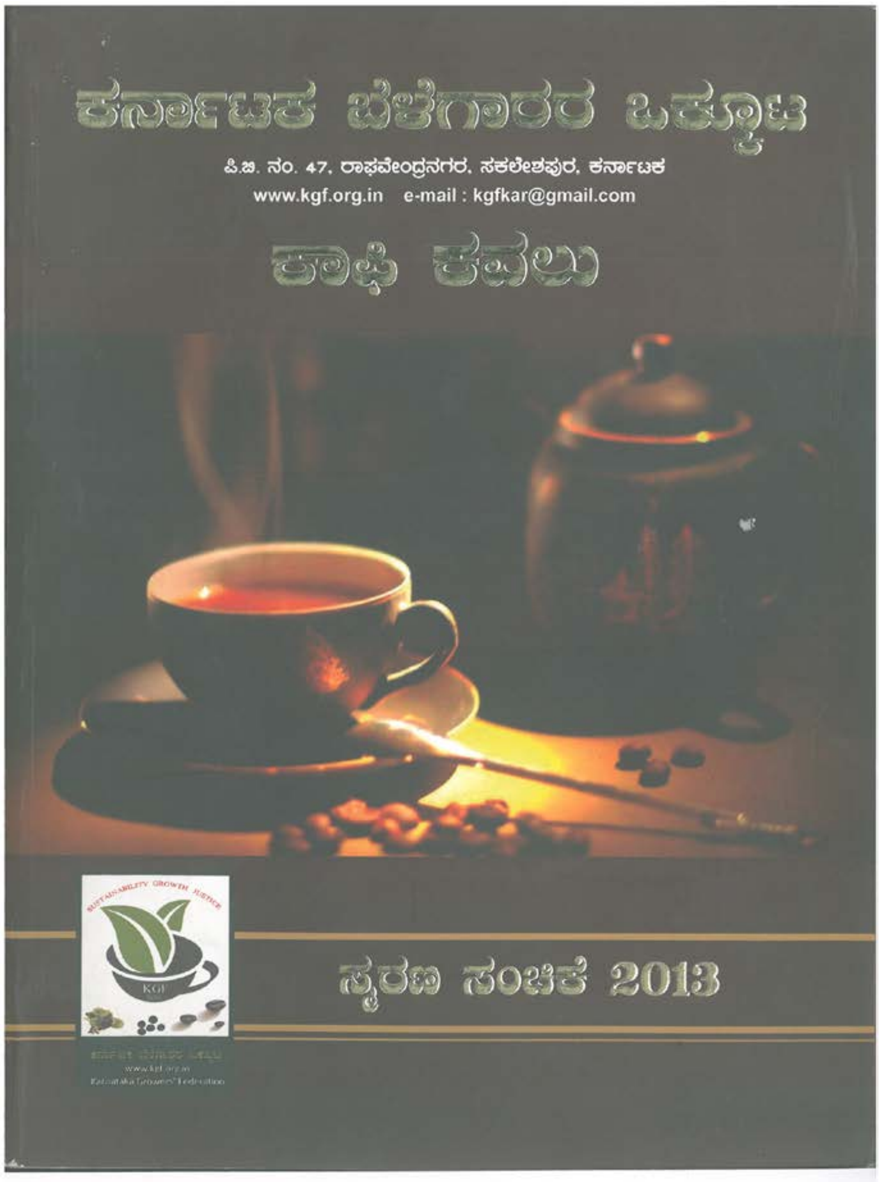
If the growers intend to share any specific problem which they find is not addressed by these questions they can mention it along with the answers to these questions. You can share the response through email or otherwise send it through post to the following address.

Email: anshuogra@gmail.com | Mobile: 7760467547
Blog: http://anshuogra.blogspot.in/
Postal address: Flat number 106, GH14, Paschim Vihar, New Delhi-87

Annexure 20

Article Published in Karnataka Growers' Federation (KGF) Souvenir

Cover page



First page of the article

Climate Change, Weather Experiences and Coffee Growers in karnataka : a research enquiry

Anshu Ogra*

"Like I said, the gods never get it right" is how I start my work on coffee growers' rich experience of weather and climate change. In a short story written by a coffee grower this line reflects how a single weather event can be experienced differently by two coffee growers having neighboring plantations. Through my Mphil work I tried to capture the highly subjective, contingent and rich weather experience of coffee growers. Till date the problem of unpredictable weather variation due to climate change is largely framed in scientific terms. There has been little inquiry into how this change is being perceived on the ground. Through my research work I tried to address this gap.

For my study I choose coffee growers because they have rich history of handling a plant which is extremely sensitive to weather variation. Moreover, coffee growers follow a peculiar tradition of maintaining rainfall records. Therefore, unlike other agriculturalists coffee growers' rich subjective weather experience can be easily substantiated with credible records. For this study I visited the coffee growing districts of South Karnataka in November 2011 for 2 months and interviewed over 46 coffee growers. Though large part of my field work was conducted in and around Sakleshpur region in Hassan District but I also got opportunities to visit some of the plantations in chickmaglur and Coorg area.

The sensitivity of coffee plant to climate has been known from very early on. John C. Winston, a British planter summarized the "paramount role of climate" in the shaping of coffee crop in his book in 1894 in following lines:

> The principal points that determine the value of location for successful and profitable cultivation of coffee are: a) soil and climate; b) situation and aspect; c) temperature and rainfall; d) proximity to the river; e) shelter from wind and wash.

A coffee grower's experience of climate and weather, as argued in my work, is very complex. Any climate change adaptation policy devoid of these experiences can do more harm than good for the growers. Through various interviews with coffee growers I gathered that it is not the ideal weather conditions that they strive to achieve in their plantation rather it is the 'band of manageable weather

Joseph M. Walsh, *Coffee: Its History, Classification and Description* (Philadelphia : The John C.Winston Co., 1894), 46, http://www.archive.org/stream/historycoffeeits00walsrich#page/46/mode/2up (accessed on 22nd June 2012).

conditions' which they aspire for. The difference between these two perspectives stands out distinctly in coffee growers response to Rainfall Insurance Scheme (RISC) introduced by Agricultural Insurance Company of India (AICI). Through the interviews and also from AICI's data it is clear that growers lack faith in this scheme. They are hesitant to believe that this scheme could address their increased vulnerability arising due to unpredictable rainfalls. My study reveals that this lack of faith is essentially because AICI fails to capture the situated meaning of rainfall for a coffee grower.

For example the success of blossom shower cannot be measured only in terms of inches of rainfall received in a specified period of time. Rather it needs to be understood in the larger context of physical and

Second page of the article

economic events happening beyond the plantations. As Geetha Suresh one of the planters in Sakleshpur mentioned that Revathi Malay is crucial for a good harvest but it only cannot ensure that we will receive a plentiful crop. In response to the untimely flowering that I witnessed at her Plantation in early December she wistfully noted "… the soil has been recently manured and this is half way into the period of dry spell. Thus even a sprinkle would initiate blossoming. But this untimely blossoming will wither away without setting the fruit. And by the time the full force of *Revathi* (Blossom Shower) comes these buds would already be lost and hence there would net loss even if *Revathi* delivers as per expectation."

Growers across the region agreed that there is change in rainfall pattern. Dr. Anand Periera, a planter as well as a research scholar pointed out that though the annual amount of rainfall received is largely the same but there is visible change in its distribution. His investments in irrigation systems aim at addressing this lateral shift in the monsoon.

Most intriguing aspect of this study was how market sensibilities actively shape coffee growers' weather experience. Multinational companies though increasing the consumption of coffee by active promotions are catering coffee blends whose composition is entirely company's prerogative. In order to keep the input cost low blends have different composition of Robustas and Chicory. Instead of growers offering what they would prefer to produce the market is covertly dictating the demand to growers in the form of Robusta. This becomes easier because in comparison to Arabica, Robusta can withstand White Stem Borer better and does not require heavy shade. But as realized by many activists, scholars and scientists switching from Arabica to Robusta has negative implications for local environment. Most prominent being loss of shade tree cover which can play havoc for local climate in the long run.

As mentioned before weather experience of coffee growers is not simplistic. It is based on the socio-economic and ecological understanding of the area. A climate change adaptation policy devoid of this rich substance will not hold any meaning for the coffee growers.

My argument to better inform adaptation policy by incorporating situated experiences has been very well received in the academic as well as policy circles. Professors at the Yale University and University East Angelia have acknowledged it as a commendable work and I intend to explore it further in my PhD programme. Through the insights gained from such international interactions I plan to provide substantial policy suggestions that can help coffee growers in adapting to changing weather patterns better.

Needless to say, this work would not have seen the light of day without the help and guidance of Karnataka Growers Federation, Centre for Social Markets, Hassan District Planter's Association and numerous coffee growers who generously spared their precious time to share their experiences with me.

At the end, I am telling the story Indian coffee grower so your suggestions and comments to improve it further, would be of immense help. You can write to me at anshuogra@gmail.com.

*Author is a pursuing her PhD at Centre for Studies in Science Policy, Jawaharlal Nehru University, New Delhi.

Annexure 21

Sample Rainfall Data Gathered from the Estates

Dundiga estate, Mudigere, Chikmaglur
1957- 2010

DUNDUGA ESTATE, MUDIGERE TALUK
YEARLY TOTAL RAINFALL FROM 1957

Sl. No.	Year	January I	January C	February I	February C	March I	March C	April I	April C	May I	May C	June I	June C	July I	July C	August I	August C	Septem I	Septem C	October I	October C	Novemb I	Novemb C	Decem I	Decem C	Total I	Total C
1.	1957	-	-	01	05	01	62	02	58	07	36	15	50	30	53	14	63	03	75	07	86	07	12	-	-	92	
2.	1958		05	-	-	-	50	04	69	03	37	14	27	39	42	12	05	07	57	04	38	01	01	-	20	87	50
3.	1959	-	-	-	-	-	-	03	32	04	70	30	10	60	19	15	77	11	52	05	65	02	61	-	40	133	76
4.	1960	-	-	-	-	02	12	02	54	06	21	15	54	28	26	10	52	06	13	08	15	04	44	-	-	84	71
5.	1961	-	-	-	-	-	06	06	14	13	83	29	55	75	66	17	20	09	52	09	68	-	23	-	16	162	33
6.	1962	-	-	-	51	-	34	04	17	05	97	05	12	46	84	26	98	10	92	15	50	05	04	03	-	124	42
7.	1963	-	-	-	16	01	07	02	13	11	88	13	23	35	57	18	85	03	69	14	87	-	10	-	89	102	34
8.	1964	-	-	-	10	-	-	1	38	3	44	17	80	40	22	48	78	07	58	09	41	02	84	02	30	132	10
9.	1965	-	10	-	00	-	-	-	92	2	60	13	68	40	91	09	11	03	96	01	29	02	26	01	56	76	67
10.	1966	-	05	-	-	-	20	02	60	05	14	06	49	28	05	05	81	15	80	08	59	02	57	-	-	73	36
11.	1967	-	08	-	-	-	-	05	88	05	86	13	93	44	81	16	84	03	46	05	45	-	55	01	60	98	46
12.	1968	-	-	-	57	-	40	06	04	04	06	08	22	32	26	12	10	05	58	05	57	01	15	-	-	75	67
13.	1969	-	-	-	-	-	-	02	45	04	63	09	50	37	-	22	25	06	97	10	01	02	35	-	60	95	94
14.	1970	-	-	-	-	-	89	06	99	04	61	11	82	21	21	16	35	08	06	12	64	-	40	-	-	82	97
15.	1971	-	-	-	-	-	-	01	13	04	80	26	22	16	39	12	67	07	99	08	53	01	97	01	11	80	81
16.	1972	-	-	-	18	-	-	01	48	09	84	11	09	23	25	08	12	07	37	11	29	01	30	-	40	74	30
17.	1973	-	-	-	-	-	-	01	43	06	20	18	27	31	67	17	71	04	70	03	91	01	74	-	66	86	83
18.	1974	-	-	-	-	01	20	01	95	03	99	04	60	32	42	17	05	13	87	03	72	-	18	-	-	78	80
19.	1975	-	16	-	20	-	99	02	64	06	19	25	07	15	49	27	03	10	21	03	28	03	31	-	-	94	57
20.	1976	-	95	-	-	-	28	02	86	-	09	11	81	27	79	15	43	11	94	01	52	07	99	-	06	79	72
21.	1977	-	-	-	-	-	58	03	57	05	75	19	08	20	09	11	33	13	52	12	03	03	78	-	-	89	31
22.	1978	-	-	-	-	-	20	03	81	05	82	19	01	24	28	24	45	07	86	06	96	03	28	-	56	96	23
23.	1979	-	-	-	-	-	81	01	70	03	07	23	11	17	39	27	97	10	23	04	88	06	07	-	-	95	23
24.	1980	-	-	-	-	-	-	06	51	04	84	33	56	32	67	16	62	05	26	05	31	04	74	-	03	109	54
25.	1981	-	-	-	-	-	78	04	50	04	12	17	08	23	43	33	14	12	42	05	74	-	83	01	18	103	22
26.	1982	-	-	-	-	-	-	02	62	05	89	12	07	27	46	25	93	03	34	03	78	-	70	-	-	81	79
27.	1983	-	-	-	-	-	-	-	28	02	81	34	21	20	80	21	23	17	25	06	21	01	65	01	98	106	48
28.	1984	-	08	-	-	05	64	05	43	01	91	31	16	30	96	10	82	08	19	03	19	-	22	-	21	98	[illegible]
29.	1985		08	-	-	01	91	02	92	04	88	[illegible]	47	11	03	16	89	05	87	04	58	02	57	-	-	65	[illegible]
30.	1986			-	29	01	02	-	[illegible]	02	52	21	72	12	24	21	68	06	59	10	22	05	21	01	43	[illegible]	[illegible]
31.	1987	-	-	-	-	-	-	-	44	03	68	07	81	11	65	10	71	07	39	09	-	02	61	01	78	55	01
32.	1988	-	-	-	68	-	-	05	91	01	38	07	73	35	30	14	95	12	28	02	99	-	22	-	06	81	50
33.	1989	-	-	-	-	-	89	-	98	02	41	12	84	30	23	11	09	06	31	05	66	-	80	-	-	71	21
34.	1990	-	73	-	-	-	-	-	-	05	42	11	83	23	75	27	68	04	36	10	99	01	30	-	-	85	86
35.	1991	-	-	-	-	-	48	06	61	08	48	25	91	35	76	13	34	04	85	10	28	01	23	-	35	107	29
36.	1992	-	-	-	-	-	-	03	47	04	23	27	04	26	45	23	65	14	03	60	20	10	98	-	-	116	05
37.	1993	-	-	-	-	-	23	02	25	06	03	20	49	23	40	17	03	03	98	13	37	-	56	-	-	87	87
38.	1994	-	75	-	10	-	05	02	98	03	93	33	69	53	32	10	25	09	68	11	56	-	81	-	-	127	02
39.	1995	-	-	-	-	-	-	03	28	04	18	08	17	36	41	14	03	09	55	05	24	02	49	-	-	83	88
40.	1996	-	35	-	-	-	05	02	66	02	18	23	28	21	91	12	76	11	35	05	03	-	05	01	90	81	98
41.	1997	-	35	-	-	03	10	01	29	04	97	14	39	35	80	22	85	04	15	08	69	04	58	02	47	102	64
42.	1998	-	-	-	-	-	-	01	77	02	98	15	08	29	94	15	04	11	62	07	05	04	17	-	49	88	07
43.	1999	-	-	-	-	-	38	01	43	09	55	14	64	32	76	09	83	04	86	16	30	-	10	-	[illegible]	89	85
44.	2000	-	30	-	-	-	-	06	39	03	22	19	38	30	08	17	36	13	26	05	93	-	50	-	13	96	57
45.	2001	-	-	-	05	-	05	08	10	03	70	18	76	16	74	13	27	07	53	03	92	04	91	-	10	77	03
46.	2002	-	-	-	14	80	90	03	46	02	45	10	05	06	65	23	31	05	74	14	83	-	38	-	-	66	[illegible]
47.	2003	-	-	-	04	01	25	01	09	01	99	13	51	20	01	10	62	02	91	08	38	-	-	-		59	[illegible]
48.	2004	-	-	-	-	-	57	03	04	11	39	30	18	07	50	19	99	05	14	07	21	01	59			56	[illegible]
49.	2005	-	02	-	-	-	-	5	72	4	75	[illegible]	[illegible]	34	92	24	58	9	16	11	81	0	51	-	-	[illegible]	[illegible]
50.	2006			-	-	1	09	1	50	9	01	20	46	31	80	19	84	11	16	4	74	6	24	-	-	105	[illegible]
51.	2007	-	-	-	-	-	-	2	81	2	20	29	99	36	68	26	73	17	48	7	19	1	13	-	-	129	[illegible]
52.	2008	-	-	3	26	9	19	0	86	2	92	18	13	17	98	28	[illegible]	10	48	6	73	0	10			98	46
53.	2009	-	-	-	-	3	30	2	18	4	35	5	63	55	77	7	58	15	86	9	04	5	12	2	68	111	[illegible]
54.	2010			-	-	-	-	6	66	2	30	12	61	22	01	22	19	15	55	5	56	13	26	0	28	103	74
55.	2011																										
56.	2012																										
57.	2013																										
58.	2014																										
59.	2015																										

Ganga Bhavani estate
1975-1999. Picture shows the rainfall data for the year 1975

RAINFALL

Date	January	Feb.	March	April	May	June	Remarks
1					3 89	- 42	
2						- 80	
3						- 57	
4							
5						- 12	
6							
7			- 8			- 38	
8			- 59		- 45		
9						- 7	
10							
11			- 32				
12			- 5				
13					- 70		
14					- 22	- 37	
15					- 47	- 11	
16		- 9					
17		- 15					
18		- 11				- 56	
19					- 27	1 - -	
20							
21					- 9	2 48	
22					- 83	3 23	
23						2 73	
24						1 65	
25					- 20	- 70	
26						- 80	
27						- 70	
28						- 70	
29					1 64	- 68	
30						1 20	
31					- 20		
Total for the month		- 35	1 04	- -	8 96	19 27	
Running Total...			1 39	1 39	10 35	29 62	

Average for .... years 19..... to 19....., Inches .... Cents ....

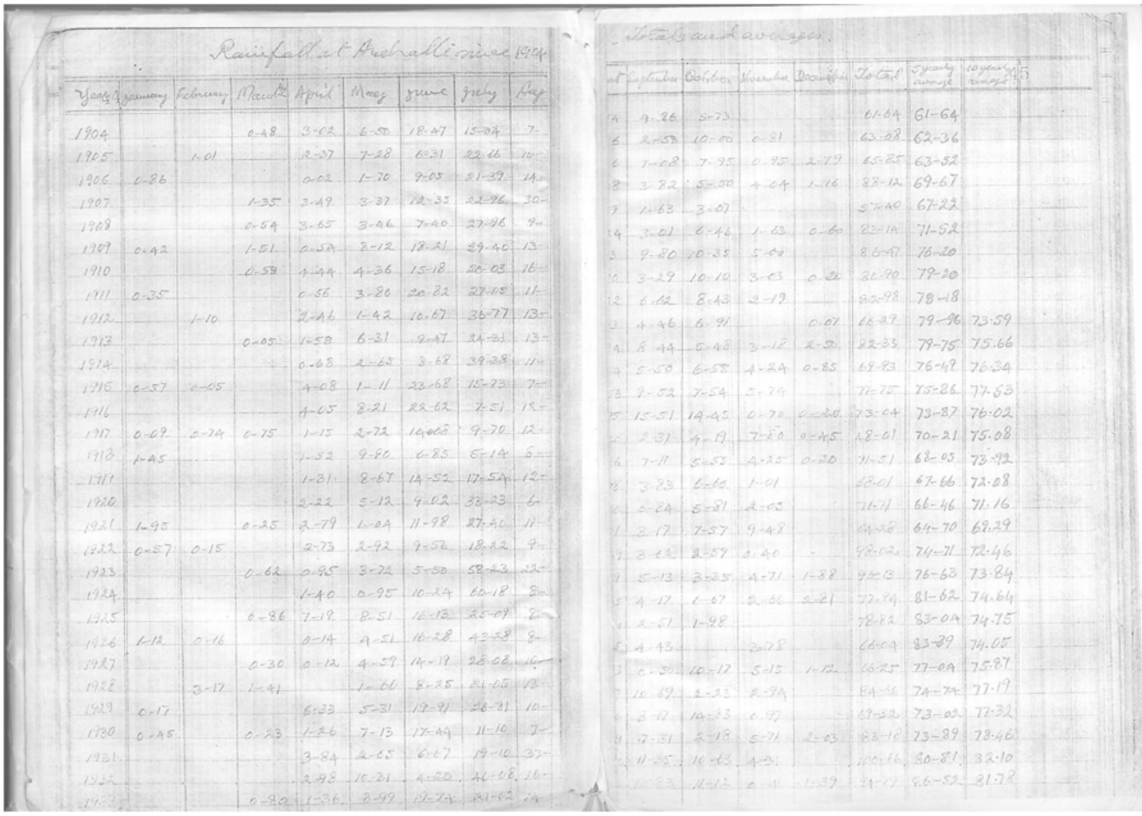
1975.-1999

Date	July	August	Septem.	October	Novem.	Decem.	Remarks
1	- 11	- 49	1 07	- 23			
2	- 6	- 60	- 37	- 34	- 88		
3	- 78	- 75	- 35	- -	- 50		
4	- -	- 70	- 25	- -	- 49		
5	- -	- 31	- 77	- 12	- -		
6	- 46	- 35	- 19	- -	- 23		
7	- 35	- 38	- -	- -	- 14		
8	- 50	- 92	- 26	- -			
9	2 62	- 57	- -	- 12			
10	1 56	- 79	1 03	- -			
11	1 88	1 63	- 42	- -	- 58		
12	- 83	2 01	- -	- 14			
13	- 30	1 20	- -				
14	- 32	1 78	- 73				
15	- 31	1 75	- -				
16	- -	- 63	- 20				
17	-	- 74	- 45				
18	- -	- 86	1 80	- 21			
19	- -	- 43	- -	- 15			
20	- 39	- 66	1 56	- 26			
21	- 43	- 11	- -				
22	- 56	- 58	2 12				
23	- 12	- -	- -	- 27			
24	- 36	- -	1 45				
25	- 52	- -	- -				
26	- 40	- 71	1 - -	- 43			
27	- 38	- 25	- 77	- 12			
28	- 14	- 85	- -	- 24			
29	- 37	- 37	- -	- 20			
30	- 25	- 54	- 38				
31	- 64	- -	- -				
Total for the month	14 64	20 66	16 37	3 23	2 82		
Running Total...	44 26	64 92	81 29	84 52	87 34		

B. R. YATHIRAJ
GANGA BHAVANI ESTATE
HANDI POST - 577 111
Chikmagalur Dist.

Total for the year. Inches 87 Cents 34

Arehalli estate (M.Atur Rahman)
1904-1987. Picture shows rainfall data form 1904-1933



Rainfall at Arehalli since 1904

Totals and averages.

Year	January	February	March	April	May	June	July	Aug	September	October	November	December	Total	5 yearly average	10 yearly average
1904			0-48	3-02	6-50	18-47	15-04	7-	9-26	5-73			61-64	61-64	
1905		1-01		2-37	7-28	6-31	22-16	10-	2-58	10-00	0-81		63-08	62-36	
1906	0-86			0-02	1-70	9-05	21-39	14-	7-08	7-95	0-95	2-79	65-85	63-52	
1907			1-35	3-49	3-37	12-35	22-96	30-	3-82	5-50	4-04	1-16	88-12	69-67	
1908			0-54	3-65	3-46	7-40	27-96	9-	1-63	3-07			57-40	67-22	
1909	0-42		1-51	0-59	8-12	18-21	29-40	13-	3-01	6-46	1-63	0-60	82-14	71-52	
1910			0-53	4-44	4-36	15-18	20-03	16-	9-80	10-35	5-00		86-47	76-20	
1911	0-35			0-56	3-80	20-82	27-05	11-	3-29	10-10	3-03	0-26	80-90	79-20	
1912		1-10		2-46	1-42	10-67	36-77	13-	6-62	8-43	2-19		82-98	78-18	
1913			0-05	1-58	6-31	9-47	24-31	13-	4-46	6-91		0-07	66-29	79-96	73-59
1914				0-68	2-65	8-68	39-28	11-	8-44	5-48	3-12	2-50	82-33	79-75	75-66
1915	0-57	0-05		4-08	1-11	23-68	15-73	7-	5-50	6-58	4-24	0-85	69-93	76-49	76-34
1916				4-05	8-21	22-62	7-51	12-	9-52	7-54	5-74		77-75	75-86	77-53
1917	0-09	0-74	0-75	1-15	2-72	14-08	9-70	12-	15-51	14-45	0-70	0-20	73-04	73-87	76-02
1918	1-45			1-52	9-80	6-85	5-14	6-	2-31	4-19	7-80	0-45	48-01	70-21	75-08
1919				1-31	8-67	14-52	17-54	12-	7-11	5-55	4-25	0-20	71-51	68-05	73-92
1920				2-22	5-12	9-02	33-23	6-	3-83	6-60	1-01		68-01	67-66	72-08
1921	1-95		0-25	2-79	1-04	11-98	27-40	11-	6-24	5-81	2-03		71-71	66-46	71-16
1922	0-57	0-15		2-73	2-92	9-52	18-22	9-	2-17	7-57	9-48		64-28	64-70	68-29
1923			0-62	0-95	3-72	5-50	58-23	22-	3-12	2-57	0-40		98-02	74-71	72-46
1924				1-40	0-95	10-24	60-18	8-	5-13	3-25	4-71	1-88	95-13	76-63	73-84
1925			0-86	7-19	8-51	16-13	25-09	8-	4-17	1-67	2-66	2-21	77-79	81-62	74-64
1926	1-12	0-16		0-14	4-51	16-28	43-28	8-	2-51	1-98			78-82	83-04	74-75
1927			0-30	0-12	4-59	14-19	28-02	16-	4-43		3-78		66-09	83-39	74-05
1928		3-17	1-41		1-60	8-25	21-05	13-	6-30	10-17	5-15	1-12	66-25	77-04	75-87
1929	0-17			6-33	5-31	19-91	28-81	10-	10-69	2-23	2-94		84-56	74-74	77-19
1930	0-45		0-23	1-26	7-13	17-44	11-10	7-	3-17	14-33	0-97		69-32	73-02	77-32
1931				3-84	2-65	6-67	19-10	33-	7-31	2-18	5-71	2-03	83-18	73-89	78-46
1932				2-98	10-21	4-22	46-08	16-	11-35	10-63	4-31		100-66	80-81	82-10
1933			0-80	1-36	3-99	19-74	21-62	14-	15-83	11-12	0-41	1-39	94-79	86-52	81-78

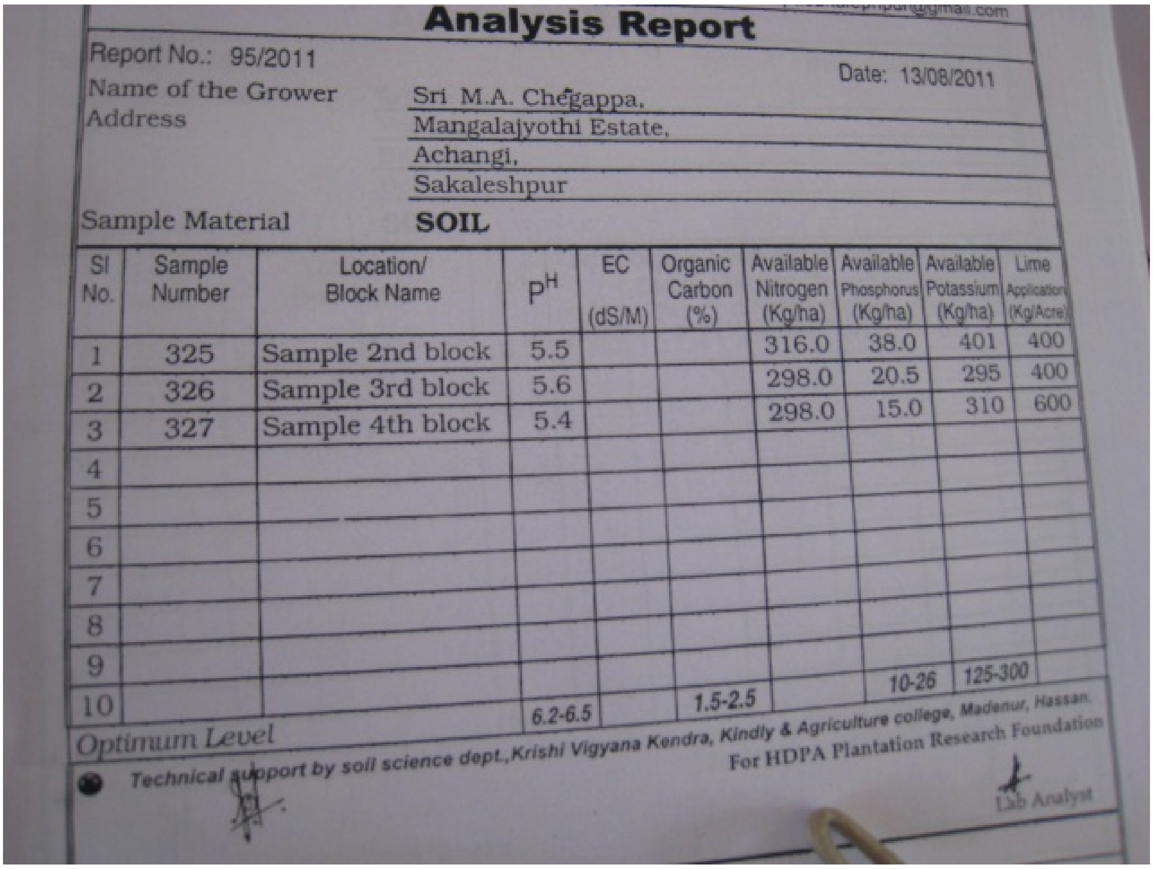
Annexure 22

Soil nutrient analysis report from Hassan District, Sakelshpur, Karnataka

This data is from a soil analysis report obtained from Soil Test Lab at Hassan District Planters Association office in Sakleshpur, Hassan, Karnataka. To see more details about the data please refer to the picture below.

Sl. No	Sample Number	Location/Block name	PH	EC(ds/)	Organic Carbon (%)	Available Nitrogen (Kg/ha)	Available phosphorus (Kg/ha)	Available Potassium (Kg/ha)	Lime application (Kg/Acre
1.	325	Sample 2nd block	5.5			316.0	38.0	401	400
2.	326	Sample 3rd block	5.6			298.0	20.5	295	400
3.	327	Sample 4th block	5.4			298.0	15.0	310	600
Optimal level			6.2-6.5		1.5-2.5		10-26	125-300	

This picture was taken on 5th December 2011 at the Soil Test Lab in Hassan District Planters Association office in Sakleshpur, Hassan, Karnataka.



Analysis Report

Report No.: 95/2011 Date: 13/08/2011

Name of the Grower: Sri M.A. Chegappa,

Address: Mangalajyothi Estate, Achangi, Sakaleshpur

Sample Material: SOIL

Sl No.	Sample Number	Location/ Block Name	pH	EC (dS/M)	Organic Carbon (%)	Available Nitrogen (Kg/ha)	Available Phosphorus (Kg/ha)	Available Potassium (Kg/ha)	Lime Application (Kg/Acre)
1	325	Sample 2nd block	5.5			316.0	38.0	401	400
2	326	Sample 3rd block	5.6			298.0	20.5	295	400
3	327	Sample 4th block	5.4			298.0	15.0	310	600
4									
5									
6									
7									
8									
9									
10									
Optimum Level			6.2-6.5		1.5-2.5		10-26	125-300	

Technical support by soil science dept., Krishi Vigyana Kendra, Kindly & Agriculture college, Madenur, Hassan.

For HDPA Plantation Research Foundation

Lab Analyst

Annexure 23

Weather records from Central Coffee Research Institute (CCRI), Balehonnur, Chikmaglur, Karnataka from 1999-2013

Maximum Temperature from 2000-2013

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Jan	28.9	29.4	28.4	29.5	29.7	**27.7**	25.3	27.5	24.6	30.6	28.69	29.31	28.80	**30.55**
Feb	30.5	31.8	30.5	31.9	31.9	**28.7**	31.4	26.9	28.7	32.5	31.59	29.72	31.55	**30.60**
Mar	33.9	32.3	33.9	33.3	34.1	**32.9**	31.7	27.2	30.4	32.5	33.48	33.34	33.25	**32.20**
Apr	32.3	31.2	32.3	32.6	31.9	**32.5**	31.8	29.9	30.9	32.0	33.04	31.33	31.71	**33.07**
May	30.6	29.3	30.6	31.0	29.1	**31.0**	31.1	26.1	29.9	30.9	30.67	30.30	30.20	**30.64**
Jun	26.3	25.1	26.3	28.6	25.7	**27.0**	26.6	25.3	26.6	27.5	27.88	25.37	26.33	**24.43**
Jul	24.7	23.9	24.7	25.1	24.6	**24.2**	23.1	24.2	25.2	24.5	24.64	24.26	24.68	**22.65**
Aug	23.8	23.9	23.8	24.6	23.3	**23.6**	22.0	24.0	24.7	25.9	24.94	24.15	24.45	**23.27**
Sep	26.6	26.8	26.6	25.6	23.5	**24.4**	23.1	24.9	27.1	26.5	26.86	25.71	26.29	**26.17**
Oct	28.3	26.8	28.3	25.4	24.1	**25.2**	24.4	25.1	28.7	27.5	27.15	28.15	27.92	**26.75**
Nov	28.4	28.3	28.4	29.0	24.2	**26.1**	22.4	24.6	28.0	28.0	26.93	27.64	27.42	**28.57**
Dec	29.0	28.1	29.0	29.8	25.4	**27.8**	20.6	24.5	29.5	28.3	27.27	27.88	28.91	**27.70**

Minimum Temperature from 2000-2013

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Jan	14.8	14.6	15.5	13.9	14.3	**14.1**	13.1	14.3	13.5	13.8	15.2	14.15	14.20	**15.42**
Feb	16.1	15.8	16.1	15.8	15.6	**14.6**	12.6	15.2	16.2	16.5	16.6	14.87	16.38	**17.00**
Mar	17.1	16.5	17.1	17.0	17.3	**16.3**	15.3	18.4	17.6	18.3	18.9	17.70	18.05	**18.94**
Apr	18.9	18.5	18.9	19.4	18.5	**17.2**	17.0	19.9	19.4	20.2	20.3	19.64	19.30	**19.01**
May	20.0	18.9	20.0	20.3	19.0	**18.2**	17.9	19.4	19.1	18.9	20.8	19.19	20.27	**20.60**
Jun	19.2	18.3	19.2	19.8	18.5	**18.1**	17.5	19.2	18.9	18.4	20.1	20.50	19.61	**19.32**
Jul	18.6	18.3	18.6	19.2	17.9	**17.6**	17.0	19.0	19.2	19.3	19.4	19.98	19.81	**19.25**
Aug	18.4	17.9	18.4	18.9	18.1	**17.6**	18.9	18.8	19.0	19.4	19.4	19.48	19.32	**19.13**
Sep	17.0	17.7	17.0	18.4	17.7	**17.5**	18.7	18.8	18.3	19.3	19.5	18.48	18.83	**19.05**
Oct	17.6	17.7	17.6	18.5	17.5	**17.0**	18.9	18.0	18.0	18.3	18.9	18.57	18.36	**19.31**
Nov	15.7	17.1	15.7	16.0	16.1	**14.6**	18.1	15.0	16.6	18.1	18.7	16.21	16.98	**17.38**
Dec	12.5	16.8	12.5	13.6	12.8	**13.8**	14.3	15.0	14.9	16.8	15.4	14.86	15.48	**15.00**

<u>1998</u>

Month	Tmax	Tmin	RH	Sunshine hours	Rain fall in mm
Jan	29.44	14.70	88.81	8.17	0.00
Feb	30.69	14.24	81.96	8.69	0.00
Mar	33.03	17.14	71.65	9.47	5.60
Apr	33.93	20.62	82.83	8.27	28.40
May	31.69	20.43	86.71	6.48	174.20
Jun	27.04	20.28	90.47	4.03	467.40
Jul	24.40	19.94	92.06	3.70	858.60
Aug	25.48	19.94	92.81	3.43	446.60
Sep	24.11	19.19	93.77	3.82	395.60
Oct	22.59	18.53	92.03	4.48	155.80
Nov	24.02	17.14	86.73	6.34	116.00
Dec	0.00	14.49	92.52	6.66	10.60
Mean	**25.53**	**18.05**	**87.70**	**0.00**	**2658.80**

1999

Month	Tmax	Tmin	RH	Sunshine hours	Rain fall in mm
Jan	0.00	12.13	83.13	8.48	0.00
Feb	0.00	14.46	79.25	9.11	0.00
Mar	0.00	17.73	85.74	9.14	18.40
Apr	0.00	18.50	84.83	8.20	35.60
May	0.00	19.20	91.65	4.80	238.30
Jun	26.12	19.25	90.07	6.08	388.60
Jul	23.85	19.34	93.48	4.45	1136.40
Aug	24.66	19.43	91.71	3.04	465.40
Sep	27.20	19.50	86.00	0.00	81.00
Oct	27.68	19.44	92.19	4.30	360.00
Nov	27.61	15.62	77.37	7.18	5.00
Dec	27.64	14.29	73.06	7.24	2.20

2000

Month	Tmax	Tmin	RH	Sunshine hours	Rain fall in mm
Jan	28.93	14.76	84.16	8.08	0.00
Feb	30.51	16.13	82.96	7.07	113.40
Mar	33.92	17.06	70.29	10.15	0.00
Apr	32.28	18.90	83.93	7.12	175.60
May	30.55	20.05	87.52	7.35	96.00
Jun	26.31	19.17	91.33	5.59	276.00
Jul	24.69	18.65	93.06	2.00	465.80
Aug	23.78	18.35	92.48	3.92	652.80
Sep	26.63	17.02	88.33	5.00	89.60
Oct	28.26	17.65	87.77	7.56	259.80
Nov	28.37	15.65	82.87	7.11	14.00
Dec	28.99	12.52	74.29	3.87	4.00

2001

Month	Tmax	Tmin	RH	Sunshine hours	Rain fall in mm
Jan	29.35	14.61	74.00	7.16	0.00
Feb	31.83	15.80	77.25	9.13	4.60
Mar	32.31	16.55	77.35	9.73	0.00
Apr	31.24	18.51	87.77	6.80	309.20
May	29.31	18.93	93.06	6.94	62.10
Jun	25.05	18.25	97.07	2.82	497.20
Jul	23.88	18.26	97.65	1.50	644.60
Aug	23.89	17.87	97.87	0.00	611.00
Sep	26.82	17.68	86.37	4.46	212.40
Oct	26.81	17.66	87.52	7.55	89.20
Nov	28.28	17.07	83.17	7.63	38.00
Dec	28.08	16.76	74.68	8.67	0.00

2002

Month	Tmax	Tmin	RH	Sunshine hours	Rain fall in mm
Jan	28.44	15.55	83.50	7.50	14.00
Feb	30.51	16.13	82.96	7.07	113.40
Mar	33.92	17.06	70.29	10.15	0.00
Apr	32.28	18.90	83.93	7.12	175.60
May	30.55	20.05	87.52	7.35	96.00
Jun	26.31	19.17	91.33	5.59	281.20
Jul	24.69	18.65	93.06	2.00	465.80
Aug	23.78	18.35	92.48	3.92	682.80
Sep	26.63	17.02	88.00	5.00	89.60
Oct	28.26	17.65	87.87	7.56	259.80
Nov	28.37	15.65	82.97	7.11	14.00
Dec	28.99	12.52	74.29	3.87	4.00
Mean	**28.56**	**17.22**	**84.85**	**6.19**	**2196.20**

2003

Month	Tmax	Tmin	RH	Sunshine hours	Rain fall in mm	0
Jan	29.52	13.87	83.13	6.97	4.60	1.00
Feb	31.93	15.84	84.50	8.11	6.00	1.00
Mar	33.34	17.00	83.65	9.73	15.00	2.00
Apr	32.60	19.36	78.67	8.22	105.60	6.00
May	31.01	20.33	80.84	8.71	0.00	0.00
Jun	28.62	19.80	86.33	4.67	377.50	16.00
Jul	25.12	19.16	92.23	1.00	559.60	28.00
Aug	24.61	18.87	93.35	0.00	517.40	26.00
Sep	25.59	18.42	86.57	3.50	70.20	11.00
Oct	25.38	18.50	88.77	4.38	205.40	10.00
Nov	28.98	15.98	86.07	4.13	0.00	0.00
Dec	29.83	13.60	81.87	6.90	0.00	0.00
Mean	**28.88**	**17.56**	**85.50**	**5.53**	**1861.30**	**101.00**

2004

Month	Tmax	Tmin	RH	Sunshine hours	Rain fall in mm	0
Jan	29.74	14.33	83.74	6.42	0.00	0.00
Feb	31.89	15.64	83.07	7.59	0.00	0.00
Mar	34.06	17.29	83.13	7.66	49.20	4.00
Apr	31.92	18.46	84.00	8.27	79.80	7.00
May	29.09	19.03	87.19	4.10	217.40	15.00
Jun	25.68	18.53	93.33	2.40	512.80	24.00
Jul	24.61	17.87	94.23	2.30	474.20	27.00
Aug	23.34	18.05	94.39	1.83	877.80	28.00
Sep	23.45	17.73	88.13	2.68	134.20	10.00
Oct	24.14	17.49	85.81	4.38	61.80	5.00
Nov	24.25	16.05	81.87	4.27	78.20	5.00
Dec	25.41	12.76	75.81	7.26	0.00	0.00
Mean	**27.30**	**16.94**	**86.22**	**4.93**	2485.40	**125.00**

2005

Month	Tmax	Tmin	RH	Sunshine hours	Rain fall in mm
Jan	27.74	14.06	82.68	6.68	2.00
Feb	28.73	14.59	81.79	7.18	0.00
Mar	32.86	16.25	75.13	7.52	0.00
Apr	32.51	17.23	81.37	4.16	278.00
May	31.04	18.21	86.74	7.21	62.40
Jun	27.00	18.09	89.63	1.63	346.00
Jul	24.23	17.65	91.16	0.00	1131.00
Aug	23.63	17.56	92.81	0.00	824.40
Sep	24.38	17.50	89.17	2.00	237.60
Oct	25.16	17.00	87.52	3.91	330.80
Nov	26.09	14.62	83.10	5.46	17.40
Dec	27.79	13.79	77.61	6.19	0.00
Mean	**27.60**	**16.38**	**84.89**	**0.00**	**3229.60**

2006

Month	Tmax	Tmin	RH	Sunshine hours	Rain fall in mm
Jan	25.27	13.08	73.81	7.94	0.00
Feb	31.43	12.57	62.96	9.09	0.00
Mar	31.72	15.32	73.19	7.48	92.00
Apr	31.83	16.98	74.60	8.45	85.20
May	31.11	17.93	84.03	6.80	171.00
Jun	26.61	17.50	90.13	1.42	447.20
Jul	23.14	17.04	92.97	0.00	870.60
Aug	21.99	18.93	94.65	0.00	644.80
Sep	23.05	18.66	90.77	0.00	186.00
Oct	24.44	18.85	81.55	6.42	44.00
Nov	22.39	18.14	87.57	4.53	235.20
Dec	20.59	14.31	75.32	6.69	12.40
Mean	**26.13**	**16.61**	**81.80**	**4.90**	**2788.40**

2007

Month	Tmax	Tmin	RH	Sunshine hours	Rain fall in mm
Jan	27.53	14.28	76.29	6.58	0.00
Feb	26.95	15.17	78.04	7.55	0.00
Mar	27.16	18.43	75.55	6.77	0.00
Apr	29.92	19.94	83.37	6.53	88.40
May	26.12	19.40	84.77	5.73	110.00
Jun	25.28	19.19	91.33	5.50	586.20
Jul	24.24	19.01	92.13	2.67	941.80
Aug	24.02	18.84	94.16	3.00	830.00
Sep	24.89	18.82	92.60	3.03	388.00
Oct	25.08	18.01	88.61	3.28	142.00
Nov	24.57	15.03	77.30	3.28	37.80
Dec	24.48	14.98	69.48	3.63	9.00
Mean	**25.85**	**17.59**	**83.64**	**0.00**	**3133.20**

2008

Month	Tmax	Tmin	RH	Sunshine hours	Rain fall in mm
Jan	24.57	13.50	80.10	3.63	0.00
Feb	28.69	16.23	81.93	7.53	94.00
Mar	30.36	17.64	79.71	5.54	270.00
Apr	30.85	19.37	85.20	7.47	70.90
May	29.87	19.14	88.06	7.60	64.00
Jun	26.57	18.95	92.23	4.68	429.90
Jul	25.21	19.24	93.16	0.00	717.90
Aug	24.73	19.03	94.16	0.00	986.20
Sep	27.06	18.30	90.57	5.26	340.10
Oct	28.66	18.01	85.06	5.19	137.70
Nov	28.04	16.56	84.10	6.38	12.20
Dec	29.50	14.92	81.97	6.34	0.00
Mean	**27.84**	**17.57**	**86.35**	**0.00**	**3122.90**

2009

Month	Tmax	Tmin	RH	Sunshine hours	Rain fall in mm
Jan	30.63	13.77	84.77	6.71	0.00
Feb	32.49	16.53	71.46	7.18	0.00
Mar	32.55	18.33	84.39	5.82	171.80
Apr	32.01	20.22	86.20	6.02	49.40
May	30.86	18.87	84.90	6.98	214.40
Jun	27.45	18.42	87.97	3.50	287.80
Jul	24.48	19.26	92.19	0.00	1296.20
Aug	25.89	19.39	90.97	0.00	259.20
Sep	26.52	19.28	91.33	3.30	481.40
Oct	27.46	18.29	81.65	5.46	234.20
Nov	27.98	18.14	84.50	4.46	119.10
Dec	28.33	16.76	85.81	2.33	39.40
Mean	**28.89**	**18.11**	**85.51**	**0.00**	**3152.90**

2010

Month	Tmax	Tmin	RH	Sunshine hours	Rain fall in mm
Jan	28.69	15.16	84.52	6.03	21.80
Feb	31.59	16.56	81.11	7.20	0.00
Mar	33.48	18.94	82.06	7.19	13.00
Apr	33.04	20.29	84.83	6.20	150.20
May	30.67	20.84	82.94	6.26	68.40
Jun	27.88	20.11	86.30	3.43	224.00
Jul	24.64	19.37	93.13	0.60	699.60
Aug	24.94	19.39	94.45	0.45	539.80
Sep	26.86	19.49	91.50	2.30	391.40
Oct	27.15	18.94	90.42	3.61	265.40
Nov	26.93	18.67	90.97	3.70	254.00
Dec	27.27	15.43	90.23	4.17	12.60

2011

Month	Tmax	Tmin	RH	Sunshine hours	Rain fall in mm	RD
Jan	29.31	14.15	76.10	6.65	0.00	0.00
Feb	29.72	14.87	73.21	7.09	9.00	1.00
Mar	33.34	17.70	70.06	7.85	3.00	1.00
Apr	31.33	19.64	83.87	5.66	156.60	10.00
May	30.30	19.19	84.68	7.21	125.10	11.00
Jun	25.37	20.50	88.60	1.38	483.30	24.00
Jul	24.26	19.98	92.29	0.37	744.30	27.00
Aug	24.15	19.48	92.13	0.13	592.00	29.00
Sep	25.71	18.48	88.67	3.25	346.00	19.00
Oct	28.15	18.57	88.52	4.98	227.60	17.00
Nov	27.64	16.21	89.13	4.93	95.20	5.00
Dec	27.88	14.86	73.87	6.29	0.00	0.00

2012

Month	Tmax	Tmin	RH	Sunshine hours	Rain fall in mm
Jan	28.80	14.20	85.16	6.10	0.00
Feb	31.55	16.38	89.69	6.81	0.00
Mar	33.25	18.05	92.19	7.15	5.00
Apr	31.71	19.30	95.47	6.12	160.20
May	30.20	20.27	85.06	6.94	39.40
Jun	26.33	19.61	85.30	1.88	242.40
Jul	24.68	19.81	90.84	0.00	403.40
Aug	24.45	19.32	88.39	0.15	804.60
Sep	26.29	18.83	83.63	1.15	185.40
Oct	27.92	18.36	78.65	2.34	70.20
Nov	27.42	16.98	75.20	2.13	130.50

2013

Month	Tmax	Tmin	RH	Sunshine hours	Rain fall in mm
Jan	30.55	15.42	70.68	4.97	0.00
Feb	30.60	17.00	67.21	4.64	45.00
Mar	32.20	18.94	74.90	4.61	61.40
Apr	33.07	19.01	78.83	5.47	44.20
May	30.64	20.60	82.32	6.52	137.10
Jun	24.43	19.32	90.27	0.68	553.70
Jul	22.65	19.25	94.29	0.02	1562.50
Aug	23.27	19.13	92.29	0.21	544.00
Sep	26.17	19.05	89.00	3.58	266.20
Oct	26.75	19.31	86.81	5.31	74.40
Nov	28.57	17.38	77.27	6.77	5.20
Dec	27.70	15.00	74.23	7.31	1.40