**Resources, Greenhouse Gas Emissions, Technology and Work in Production and Distribution Systems: Materiality in Rice in India**

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***Introduction:***

In this paper we introduce a project of research to ascertain the opportunities for integrating decent work[[1]](#footnote-1) with means of lowering the resource intensity and carbon content of a system of production and distribution – with a case study of rice in India. Innovative conceptual, methodological and practical tools are intended to be produced for application to other production systems. Such techniques are needed for planning and incentivising future economic growth with lower resource intensities which also addresses pervasive under- and unemployment - conditions affecting many countries, not the least India (ILO, 2008).Resource security and climate change are increasingly important meta-factors with profound implications for the future of development theory and practice (Boyd and Juhola 2009). The link between these factors and the socio-economic conditions conducive to decent employment – which is strongly associated with poverty alleviation (Chen, Vanek et al. 2004) – has not, to date, had remotely sufficient theoretical or empirical investigation.

***Background and motivation:***

This paper and the research we propose address two key problems of global relevance which are central to India’s future

development:

1. the resource and carbon intensity of economic growth;

2. under- and un-employment.

At the national level India ranks fourth globally in terms of current emission flows (Atteridge et al, 2009) while its contribution to total cumulative atmospheric carbon stocks is low. However, continued heavy reliance on fossil fuels (particularly coal), economic expansion and reduced energy poverty means this contribution will grow (Srivastava, Mathur et al. 2006). There will be increasing pressure for low[er]-carbon and resource intensive economic growth, whether that be through participation in climate governance regimes and their associated flexibility mechanisms (such as the Clean Development Mechanism)(Joshi and Patel 2009), for immediate reasons of energy and resource security (Srivastava, Mathur et al. 2006; IEA 2007) or in the stated self-interest of the Indian government (for example the National Action Plan on Climate Change (Government of India, 2008a)).

Under- and un-employment is a massive development problem in India: only 42% of the population was employed (formally or informally) for more than half of the preceding year in the 2004/5 NSSO survey round (NSSO 2006). Most work takes place in the informal economy, outside of the state’s regulatory reach, where workers do not have secure contracts, work rights or social protection, and where wages are mostly below the official minimum (Harriss-White and Sinha 2007). Estimates of informal employment range from between 83% and 93% of the labour force[[2]](#footnote-2) , producing around 60% of GDP (Harriss-White 2003; Harriss-White, Adam et al. 2007). The Indian Government (GoI) notes that “lack of access to employment that is decent and remunerative, lowers self-esteem and leads to denial of basic needs of the individual and the family”, making the provision of decent work for all who would like it a policy priority (Government of India 2008). Informal work in India is also on the increase both absolutely and relatively (Chen, Vanek et al. 2004; Harriss-White and Sinha 2007). The biggest challenge for employment policy is to improve conditions outside the current reach of the state.

The central stated priority of the GoI is economic and social development and the eradication of poverty (Government of India 2008). This is the context for the official framing of responses to climate change, and for plans for energy development and resource security. Yet, the implications of the informal economy – the locus of poverty and of final demand for the most polluting products of the formal sector and by definition marginalized from the policy process – for India’s response to climate change and energy security go unmentioned in existing policy analyses of these issues (see for example: Government of India 2006; Government of India 2008). It is important, then, to identify mitigation-development co-benefits, in the context of informal economic activity and informal labour, in the interests of improving both (Atteridge, Nilson Asberg et al. 2009). This is a research agenda to which our research is intended to contribute.

Investigating carbon and resource efficient growth pathways has been identified as a research priority by aid agencies and development institutes worldwide (DFID 2008; DIIS 2009; Urban and Sumner 2009, UNDESA, 2010, Bhushan, 2011). The distributional implications of different types of low carbon development are seriously under-researched (Renner, Sweeney et al. 2008; Urban and Sumner 2009). In particular, while literature on the ‘productive uses of energy’ emphasises the use of sustainable sources of energy for productive development outcomes, including employment generation (Cabraal, Barnes et al. 2005; Barnes 2007; GNESD 2007), there is much less attention paid to potentially productive outcomes arising from resource and energy efficiency – where our research is planned to be relevant. In the minority of cases in which the literature on productive uses of energy examines employment, it tends to focus on employment generation or income improvement and not on the quality of employment provided or the socio-political processes that lead to employment outcomes (for an exception see: Kooijman-van Dijk 2008).

In the context of new production systems and technology uptake, the ILO’s concept of decent work and decent work deficits[[3]](#footnote-3) (ILO 1999) is a tool to remedy this neglect . We intend to build on the valuable research that uses the decent work idea in an Indian context (Unni and Rani 2003; Kantor, Rani et al. 2006). More broadly this research will contribute concepts, methods and empirical evidence to the movements and agendas for ‘green jobs’ to help fill ‘huge gaps in our knowledge and available data, especially as they pertain to the developing world’ (Renner, Sweeney et al. 2008, p.3).

A second aspiration lies in fusing literatures and methodologies in several subfields[[4]](#footnote-4), notably those of value chains and of life cycle assessment (LCA). The former was developed for the analysis of economic rents, governance and innovation in chains of physical activity spanning the globe (Kaplinksy and Morris 2001) and has been adapted for local production systems (Ruthven, 2008); the latter has engaged with systemic resource budgeting at each stage of the life of a commodity (ISO 2006). Our research needs to fuse these currently separate frameworks in a new way (developed below). This supply chain based perspective is necessary because technologies and techniques of production are recognised to be constituted by, and constitutive of, broader social relations, in ‘socio-technical systems’ (Bijker 1995; Leach, Scoones et al. 2010). Socio-technical systems are in turn embedded in systems of provisioning whose accumulation processes embody social and political dynamics that enable and constrain participants in important ways with respects to resource use, technology choices, the use and structuring of labour power and their relationship with the state (Friedland and Barton 1981; Cowan 1987; White 2009). By analysing production systems as extensively as possible, insights will be gained into the systemic influences and determinants of employment and resource distributions, and the regulation of innovation. These insights should help shape social and technological change to lower GHG emissions.

Rice has been chosen as a case study not because it is one of the big polluters[[5]](#footnote-5) but instead for the following reasons –Employment, poverty reduction and resource use are closely entwined in agriculture and food production systems (World Bank 2007). Agriculture is materially complex, being estimated to generate between 10-12% of GHGs globally and 18% of India’s emissions, whilst also having a strong role in sequestering carbon (Metz, Davidson et al. 2007; FAO 2009; INCCA 2010). Its production uses 85% of water for agriculture in developing countries (World Bank 2007). Rice is a staple foodstuff for the majority of Indians and its production, trade and distribution take place overwhelmingly in the informal economy using pauperised labour (Harriss 1981; Harriss-White 1996; MCA 2006; Harriss-White 2008; Harriss-White forthcoming). Normatively, there is also a recognised need to develop rice production systems that are less reliant on scarce inputs, particularly water, but which generate employment benefits (Central Rice Research Institute 2006; Shambu Prasad 2006; Nelson, Robertson et al. 2009). The research proposed here will draw from nearly 40 years of (ODA/DFID funded) research into agricultural production and marketing in SE India, particularly rice (Farmer 1977; Hazell and Ramaswamy 1991; Harriss-White and Janakarajan 2004; Harriss-White forthcoming).

***Research Questions and Objectives:***

1. *What opportunities are there to reduce the resource intensity and GHG emissions of rice production systems, whilst maximising the quality and quantity of employment provided?*

The interconnected nature of production systems requires the clarification of the key social institutions, economic flows and physical dynamics of entire production systems as they actually exist in order to identify normative aspects reducing GHGs and improving employment (White 2009). These are elaborated in the objectives below.

Four farm-based technologies/techniques will be examined: rainfed, organic, irrigated High Yield Variety (HYV) and systems of rice intensification (SRI). A diversity of post-harvest processing technologies will be examined: parboiling, hulling/husking, rubber-roll shelling, and integrated rice milling. And four distribution channels: informal retail, registered firms, India’s Public Distribution System (PDS)[[6]](#footnote-6) and supermarket supply-chains. The resources/emissions accounted for will involve water, energy, greenhouse gas emissions and nitrogen.

1. Determine the life cycle resource intensity and GHG emissions of rice production, processing and distribution practices and technologies.
2. Ascertain the distribution of value (using market and opportunity costs and prices) among the supply chain actors, including employees, and account for factors structuring this distribution.
3. Determine the quantity of jobs and their quality across production and distribution systems, and account for factors structuring this distribution.
4. Determine what opportunities exist for improving employment quantity and relations, when and why these opportunities arise and the roles of policy and technology choice in this process.
5. Ascertain how (informal and state mediated) regulative practices and technologies mediate the resource intensity of production and the distribution of value and employment relations in rice production.
6. Determine what processes regulate innovation and the diffusion of technologies in the registered, state, and informal institutions of production and distribution.

2. *How are resource use, practice/technology, costs and decent employment trade-offs to be assessed?*

Trade-offs between resource efficiency, GHG reduction, value addition and employment are inevitable. Appraisal tools such as multi-criteria analysis have been developed for conditions when the trade-offs are incommensurable (Dogson, Spackman et al. 2000). A suitable tool for measuring and working through trade-offs in order that social benefits might be maximised and economic costs and material burdens minimized needs developing for our research questions. Hence:

1. Review and evaluate different appraisal techniques, justify the selection of one to explore further.
2. Use the proposed method with stakeholders, in order to examine conflicts and trade-offs in desirable outcomes in different production and distribution systems.
3. Use this process to identify opportunities to improve existing production systems from a social perspective, in particular quality employment maximisation.
4. Evaluate the strengths and weaknesses of the method used.

Research on HYV and SRI based production systems is expected to be based in the Vellore and Tiruvannamalai districts of Tamil Nadu whose production and markets have been studied every decade since the early 1970s. Research on organic production will be based in one or a combination of Warangal, Nalgonda and Kurnool districts of Andhra Pradesh, and rainfed production in Rayagada and Kalahandi districts of Orissa.

***Proposed Research Methods:***

*Question 1*: Three methodological approaches will be used to answer the first research question. Life cycle assessment (LCA) will be used to measure the resource intensity of the rice production systems (Q1, objective a and e). LCA is an environmental accounting method that quantifies resource and pollution inputs and outputs along a supply chain (ISO, 2006). Second, value chain analysis (VCA) will be used to understand the labour process and the distribution of value addition, both across and within, different segments of the supply chain (Q1, b, c, d, f). VCA, would be used as a socio-economic tool in this context which seeks to understand how the broader institutional arrangement and its governance structure influences the generation and distribution of value in the supply chain across the different production systems. The focus of the VCA approach would be to assess the ‘economic’ value addition and hence all costs would be estimated in terms of ‘opportunity’ costs. Where market prices do not reflect true opportunity costs, the costs would be imputed. The VCA would also elaborate on the roles of labour and technologies in value chain governance and value distribution (see Barrientos and Kritzinger 2004; Nadvi 2009 for an exploration of labour relations), and would add insights from the innovations literature regarding practice/technology diffusion (reviewed with respect to the informal economy in Roman 2008).

Third, a field economics method will be used to examine the social structure of production-distribution systems (Q1, b, c, d) (see Harriss-White 2003). Social institutions regulate India’s economy. In particular caste, gender and religion, the (shadow) state, labour (unions) and capital (trade/business associations and local chambers of commerce), “keep accumulation highly localised, shape the way labour is controlled, limit competition and perpetuate the toleration of vast negative environmental externalities” (p.244, Harriss-White 2003).

By developing these methods for a range of forms of rice production and distribution, causal and consequential links between elements (technologies/practices and their diffusion, labour, resources, emissions, value and the socio-economic and policy institutions that regulate the system) can be mapped, characterised and quantified. The role of one factor in mediating others can be ascertained (Q1, e). Fieldwork will occur in three stages: mapping the value chain, governance, and technology uptake. These are briefly elaborated below, after an overview of the sampling strategy.

Sampling strategy: The main focus of this research will be on firms at the production and post-production stages of the rice system. At the farming and processing stages the sample of firms will be primarily stratified according to technology/technique and scale of enterprise. Geographical stratification may also be used if deemed necessary. At the distribution stage firms representing four routes to the consumer will be investigated: informal firms, registered firms, the PDS and supermarkets.

Exact sample sizes will depend on estimates of population sizes, however it is anticipated that in the region of 120 farms (relatively large and small) and 80 processing/trading firms will be randomly sampled from technology/practice-based pools.. The social and economic characteristics of each sampled business will be detailed so that potential co-variance can be accounted for. Return visits may be needed in order that both firms and representatives from each main employment category are sampled and to ensure that temporal/seasonal and spatial diversity is captured. In addition, interviews will be conducted with industry representatives, policy makers and implementers, and research-based and practice-based technological innovators (anticipated to be 30 additional interviews). As in previous field research in rice markets a snowball sampling strategy will be used for these additional interviews.

Mapping the value chain: Here LCA and VCA will document human and non-human actors and their relationships, and will quantify resource and economic flows between them. From this Q1, objectives a,b and c will be achieved. Careful attention will be required in drawing boundaries around the case-study system given that production systems and markets are not independent of each other (White 1993; Harriss-White 1996), and do not have obvious boundaries (ISO 2006). We will start by assuming system closure at the inputs stage upstream and final purchase for consumption downstream[[7]](#footnote-7), but, time permitting, may extend this to the cooked product, due to the important relationships between health, poverty, and climate change, as well as wider environmental degradation. A new set of rules and processes for closure will be developed with collaborators to ensure consistency. To complete the LCA, a mathematically simple but thorough numerical model corresponding to the inventory and impact assessment stages of LCA will be developed in Excel (SAIC 2006).

Physical flows of materials, energy use, greenhouse gas emissions, economic inputs and outputs,

technologies and their ownership, regulatory and contractual/trading relations and labour relations will be mapped, quantified (for materials, energy, capital and employment) and categorised. The latter analysis will delineate labour relations (according to the ILO decent work framework following Kantor et al (2006)), together with the regulative relations of caste, kin, religion, class, gender and policy interactions for all supply chain actors (Harriss-White 2003). Informality is experienced differently according to the balances and roles of these aspects of social identity and their related economic agency (Chen, Vanek et al. 2004).

Mapping will be informed by company inventories (where existing and volunteered), surveys involving interviews (at the firm and industry representative levels), case material (where volunteered), state level agricultural and processing statistics and data from state organisations. The life cycle inventory will draw from these sources as well as previous LCA studies and if necessary LCA inventories (e.g. Ecoinvent 2010). Where possible, historical data for the preceding 3-5 years for all variables will be sought to allow for a dynamic picture of physical and economic flows to emerge (Kaplinksy and Morris 2001).

Governance: Mapping will develop a quantitative/categorical representation of the value chain. A further layer of qualitative research will be undertaken in order better to understand the economic, formal/policy and informal/social institutions and power relations through which rice flows, and as a result of which the accumulation and distribution (of economic resources and employment) take place. This will be done using field methods involving stakeholder interviews and will contribute towards answering Q1c, d. Again, emphasis will lie on past experience to ensure that dynamics in the system over time are captured (e.g. in relation to seasonal changes and the food price spikes of 2007/8).

This will require longer exposure to supply chain actors, with information collated through semi-structured interviews and field observation along the production chain and with regulatory/legislative actors. The implementation of the Regulated Agricultural Markets Act. The management of the Public Distribution System and the enforcement of the Labour Laws are candidates for field research (Harriss-White 2003; Breman 2007). Particular attention will be paid to how social and political institutions structure the behaviour of formal and informal firms and workforces. Through interviews, historical profiles of circumstances where the number and/or quality of jobs has changed, will be sought (Q1,d). Participant observation of employment or commercial negotiations or relevant discussions will be undertaken if the opportunity arises.

Technology Uptake: Here research will focus on the process of problem and technology framing, innovation and choice, implementation and know-how. The literature on science and technology assumes lab-based innovation and a technology or innovation system for development and diffusion. These assumptions are open to critical scrutiny in the informal economy. Through semi-structured interviews, field observation, technology tours and reviewing manuals/ technology markets a picture will be developed of why particular types of technology are used, how innovation takes place in the informal economy and what influences this process, thus answering Q1,f. By comparing the different technologies and operational scales, asking respondents about changes over time, and drawing on previous fieldwork on technological change in the region (Harriss 1976; Harriss-White 1996; Harriss-White

forthcoming), we will research whether and how the process of technology uptake and use has altered, been shaped by, or re-organised production and employment relations in the variety of micro-institutional contexts taken for research. Aware that technological change has both transition costs and spillover, we will also explore these where this is possible.

Framework and methods for analysis: LCA and VCA already embody basic frameworks for analysis producing an account of emissions, resource use/kg rice, and value accrual for each stage and process of production. A new conceptual framework is being developed that will provide working hypotheses and a schematic to guide analysis, focussing on eliciting causal relationships between resource use and costs, practices/technology, social institutions regulating accumulation and labour relations. We will then use this to ask how these relations enable or constrain opportunities for change. The initial set of research findings will be discussed iteratively with a sub-set of supply chain, governance actors and state authorities in order to gain feedback on our analysis, ensure comprehensiveness and gain further insights on our interpretation of findings.

*Question 2*: A desk-based literature review and practitioner consultation (including participants at the inception workshop) will evaluate the appropriatness of existing appraisal methods given the issues at stake and the country and sectoral context of this research project. From this, one appraisal method will be chosen (or developed, integrating more than one) to use in a further workshop (Q2a). This process will also refine a key set of criteria against which the utility of the appraisal method can be evaluated (Q2d).

A final workshop will be held at the end of the research seeking to bring together a wide selection of stakeholders. Findings from the first stage of field work will be but one evidence base from which to draw; a diversity of knowledge, perspectives and experience will be recruited. Representatives of potentially marginalised groups of workers through the VCs will expressly be invited to participate. The primary aim of this workshop will be to develop ways to identify and address the trade-offs between beneficial outcomes throughout the system (decent employment, equitable value addition, less destructive natural resource use/pollutants) so that those means of production with fewest trade-offs can be recognised (this may not be a particular technology/practice, but a set of elements/characteristics/practices) (Q2b) and/or the implications of alternatives with strong benefits in GHGs reduction and improved employment may be assessed.

Ways in which the social benefits of existing systems of rice production can be enhanced will also be explored (Q2c). The secondary aim of the workshop will be to determine the usefulness of the appraisal method developed, with a view to improving it or determining needs that might be better met with another appraisal procedure. This will use the criteria derived in the literature review undertaken, as well as any other criteria justified as important by the stakeholder group attending.

***Expected outputs***:

This research is intended to produce two primary substantive outputs: a systemic empirical comparative case-study of the links between the use of technologies/techniques, resource/GHGs and decent work deficits/rankings ; and an example of how trade-offs between desirable outcomes can be worked through. As a pilot project, it will also generate a host of questions about methods and will use the substantive project to contribute answers to as many as possible within the time frame.

Due to its novelty, the primary impact of this research is anticipated to be in the form of learning: about methods and concepts for application to other systems of production, and the potential for synergies or antagonisms (between labour, market and social costs, resource use and pollution) for future development or investigation.

Throughout the project, essays and discussion notes will be posted on a website - to be developed. (The portal Scidevnet is a possibility - currently, see <http://www.southasia.ox.ac.uk/research/research_projects/professor_barbara_harriss-white> for links). We would all be keenly interested in comments and criticisms and in collaborating on further expansion of these themes and applications of the methods.

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***References:***

Atteridge, A., G. Nilson Asberg, N. Goel, A. Kumar, M. Lazarus, M. Ostwald, C. Polycarp, P. Tollefsen, A. Torvanger, P. Upadhyaya & L. Zetterb erg. 2009. Reducing GHG emissions in India. Financial mechanisms and opportunities for EU-India Collaboration. Stockholm,

Sweden: Swedish Ministry of the Environment, Stockholm Environment Institute.

Barnes, D. F. 2007. The Challenge of Rural Electrification. In *The Challenge of Rural*

*Electrification, Strategies for Developing Countries*. Washington: Resources for the Future.

Barrientos, S. & A. Kritzinger (2004) Squaring the Circle: Global Production and the

Informalization of Work in South African Fruit Exports. *Journal of International*

*Development,* 16**,** 81-92.

Bhushan, C. (2011) Equity and the Transition to a Low Carbon Economy; Centre for Science and Environment, New Delhi <http://www.cseindia.org/userfiles/CB-Challange-of-the-new-balance-Durban.pdf>

Bijker, W. (1995). *Bicycles, bakelites and bulbs: toward a theory of sociotechnical change*.

Cambridge, MA: MIT Press.

Boyd, E. & S. Juhola (2009) Stepping up to the Climate Change: Opportunities in Re-

Conceptualising Development Futures. *Journal of International Development,* 21**,** 792-804.

Breman, J. 2007. *The Povery Regime in Village India: Half a Century of Work and Life at the*

*Bottom of the Rural Economy in South Gujarat*. Oxford: Oxford University Press.

Bridge, G. & A. E. G. Jonas (2002) Guest Editorial. Governing nature: the reregulation of resource access, production, and consumption. Governance, institutions, and resource extraction. *Environment and Planning A,* 34**,** 759-766.

Cabraal, R. A., D. F. Barnes & S. G. Agarwal (2005) Productive Uses of Energy for Rural

Development. *Annual Review of Environment and Resources,* 30**,** 117-44.

Central Rice Research Institute. 2006. Vision 2025, Perspective Plan. Cuttack, Orissa: CRRI, Indian Council of Agricultural Research.

Chen, M. A., J. Vanek & M. Carr. 2004. *Mainstreaming Informal Employment and Gender in*

*Poverty Reduction. A Handbook for Policy-makers and other Stakeholders*. Ottowa:

Commonwealth Secretariat/IDRC.

Cowan, R. S. 1987. The Consumption Junction: A Proposal for Research Strategies in the

Sociology of Technology. In *The Social Construction of Technological Systems,* eds. W. E.

Bijker, T. P. Hughes & T. J. Pinch. Cambridge, Massachusetts: MIT Press.

DFID. 2008a. DFID Research Strategy 2008-2013. . In *Working Paper Series: Climate Change*. London: Department for International Development.

---. 2008b. Working Paper Series: Sustainable Agriculture. In *DFID Research Strategy 2008-2013*.London: Department for International Development.

DIIS. 2009. Reducing Poverty through Low Carbon Development. Recommendations for

Development Cooperation in Least Developed Countries. In *DIIS Policy Brief: Climate*

*Change*. Copenhagen: Danish Institute for International Studies.

Dogson, J., M. Spackman, A. Pearman & L. Phillips. 2000. Multi-Criteria Analysis Manual.

London: DCLG.

Ecoinvent. 2010. *Ecoinvent Database v2.2*. St-Gallen, Switzerland: Swiss Centre for Life Cycle Inventories.

FAO. 2009. Enabling Agriculture to Contribute to Climate Change Mitigation. FAO submission to the United Nations Framework Convention on Climate Change (UNFCCC). Rome: Food and Agriculture Organisation.

Farmer, B. H. 1977. *Green Revolution? Technology and Change in Rice-Growing Areas of Tamil Nadu and Sri Lanka*. London: MacMillan.

Friedland, W. H. & A. E. Barton. 1981. *Manufacturing Green Gold: Capital, labour and*

*technology in the lettuce industry*. Cambridge: Cambridge University Press.

GNESD. 2007. Renewable Energy Technologies and Poverty Alleviation: Overcoming Barriers and Unlocking Potentials. Roskilde, Denmark Global Network on Energy for Sustainable

Development.

Government of India. 2006. Integrated Energy Policy. New Delhi: Planning Commission.

---. 2008a. National Action Plan on Climate Change. Delhi: Prime Minister's Council on Climate Change, GoI.

---. 2008b. National Employment Policy. Delhi: Directorate General of Employment and Training, Ministry of Labour.

Harriss-White, B. 1996. *A Political Economy of Agricultural Markets of South India: Masters of the Countryside*. New Delhi: Sage Publications.

---. 2003. *India Working: Essays on Society and Economy*. Cambridge, UK: Cambridge University Press.

---. 2005. Poverty and Capitalism. In *QEH Working Paper Series - QEHWPS134*. Oxford: Queen Elizabeth House Department of International Development.

---. 2008. *Rural Commercial Capital: Agricultural Markets in West Bengal*. Oxford: OUP.

---. forthcoming-a. *Local Capitalism and the Foodgrains Economy in Northern Tamil Nadu, 1973- 2010*. New Delhi: Three Essays Press.

---. forthcoming-b. Rural-Urban Development through Four Decades - the Dynamism of Small Town India. Oxford: OUP.

Harriss-White, B., C. Adam & A. Sinha. 2007. Chapter 7: Summary and Conclusions. In *Trade liberalization and India’s informal economy,* eds. B. Harriss-White & A. Sinha. Oxford: Oxford University Press.

Harriss-White, B. & S. Janakarajan. 2004. *Rural India Facing the 21st Century*. London: Anthem Press.

Harriss-White, B. & A. Sinha. 2007. Trade Liberalization and India’s Informal Economy. Oxford: Oxford University Press.

Harriss, B. (1976) Paddy Processing in India and SriLanka: A Review of the Case for

Technological Innovation. *Tropical Science,* 18**,** 161-186.

---. 1981. *Transnational Trade and Rural Development: Rice in Tamil Nadu*. Noida, Uttar Pradesh: Vikas Publishing.

Hazell, P. & C. Ramaswamy. 1991. *The Green Revolution Reconsidered: the Impact of Highyielding Rice Varieties in South India*. London: Johns Hopkins University Press.

IEA. 2007. World Energy Outlook: China and India Insights. Paris: International Energy Agency.

ILO. 1999. Report of the Director-General: Decent Work. Geneva: International Labour

Organization.

INCCA. 2010. India: Greenhouse Gas Emissions 2007. Delhi: Indian Network for Climate Change Assessment and Ministry of Environment and Forests.

ISO. 2006. ISO 14040. Environmental management - Life cycle assessment - principles and

framework. Geneva, Switzerland: International Standards Organisation.

Joshi, V. & U. Patel. 2009. India and Climate Change Mitigation. In *The Economics and Politics of Climate Change,* eds. D. Helm & C. Hepburn. Oxford: OUP.

Kantor, P., U. Rani & J. Unni (2006) Decent Work Deficits in Informal Economy. Case of Surat. *Economic and Political Weekly,* 27 May.

Kaplinksy, R. & M. Morris. 2001. A handbook for value chain research. In

*http://asiandrivers.open.ac.uk/documents/Value\_chain\_Handbook\_RKMM\_Nov\_2001.pdf*

Ottowa: International Development Research Centre.

Kooijman-van Dijk, A. L. 2008. The Power to Produce. The role of energy in poverty reduction through small scale enterprises in the Indian Himalayas. PhD Thesis. Enschede: University of Twente.

Leach, M., I. Scoones & A. Stirling. 2010. *Dynamic Sustainabilities. Technology, Environment,Social Justice*. London: Earthscan.

MCA. 2006. Annual Report 2005-06. New Delhi: Ministry of Consumer Affairs, Department of Food and Public Distribution.

Metz, B., O. R. Davidson, P. R. Bosch, R. Dave & L. A. E. Meyer. 2007. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge and New York: Cambridge University Press.

Nadvi, K. (2009) Globalisation and Poverty: How can Global Value Chain Research Inform the Policy Debate? *IDS Bulletin,* 35**,** 20-30.

NCEUS. 2009. The Challenge of Employment in India. An Informal Economy Perspective. New Delhi: National Commission for Employment in the Unorganised Sector, Government of India.

Nelson, G. C., R. Robertson, S. Msangi, T. Zhu, X. Liao & P. Jawajar. 2009. Greenhouse Gas

Mitigation. Issues for Indian Agriculture. In *IFPRI Discussion Paper 00900*. Washington:

International Food Policy Research Unit.

NSSO. 2006. Employment and Unemployment Situation Among Social Groups in India 2004-2005. In *NSS 61st Round (July 2004-June 2005)* Delhi, India: National Sample Survey

Organisation, Ministry of Statistics and Programme Implementation, Government of India.

Planning Commission. 2008. Agriculture, Rural Development, Industry, Services and Physical Infrastructure. In *Eleventh Five Year Plan (2007-2012) Vol. III*. New Delhi: Government of India.

Renner, M., S. Sweeney & J. Kubit. 2008. Green Jobs: Towards Decent Work in a Sustainable, Low-Carbon World. Nairobi: UNEP.

Robbins, P. 2004. *Political Ecology*. Maldon, MA and Oxford, UK: Blackwell Publishing.

Roman, C. 2008. Learning and Innovation Clusters: Case Studies from the Indian Silk Industry. In *QEH Department of Development*. University of Oxford.

Ruthven, O. (2008) XXXX D Phil. Thesis, Oxford University

SAIC. 2006. Life Cycle Assessment: Principles and Practice. Reston Virginia and Cincinnati Ohio: Scientific Applications International Corporation and U.S. Environmental Protection

Agency.

Shambu Prasad, C. 2006. System of Rice Intensification in India. Innovation history and

institutional challenges. Hyderabad and Bhubaneswar: WWF and Xavier Institute of

Management.

Srivastava, L., R. Mathur, P. Dadhich, A. Kumar, S. Marwah & N. Goel. 2006. National Energy Map for India:Technology Vision 2030. New Delhi: The Energy and Resources Institute and the Office of the Principal Scientific Adviser, Government of India.

UNDESA, 2010, Technology Development and Transfer for Climate Change, UNDESA/UNIDO <http://www.un.org/esa/dsd/resources/res_pdfs/publications/sdt_tec/Survey_of_TT_Activities_by_UN_Organizations.pdf>

Unni, J. & U. Rani (2003) Social Protection for Informal Workers in India: Insecurities, Instruments and Institutional Mechanisms. Development and Change, 34, 127-61.

Urban, F. & A. Sumner. 2009. After 2015: Pro-Poor Low Carbon Development. In IDS In Focus Policy Briefing. London: Institute of Development Studies.

White, G. (1993) The Political Analysis of Markets. IDS Bulletin, 24, 4-11.

White, R. 2009. Carbon Governance in UK Liquid Milk Systems. Oxford: Environmental Change Institute, Oxford University.

World Bank. 2007. World Development Report 2008: Agriculture for Development. Washington

DC: World Bank.

1. Decent work, as defined by the International Labour Office, emphasizes four elements: employment (adequate opportunities and remuneration, safety at work and healthy working conditions), social security, workers rights and social dialogue. [↑](#footnote-ref-1)
2. The informal economy is the economy not covered by official data on registered enterprises, applying to both enterprises and employment relations. This includes subsistence production, petty trade, small scale commercial production, and the casualisation of labour by registered commercial firms and public enterprises to increase flexibility/reduce costs. [↑](#footnote-ref-2)
3. Achieving decent work is a gradual process, with the measure of decent work deficits allowing for an ordinal comparison of amounts and types of decent work deficits. [↑](#footnote-ref-3)
4. Currently: the informal economy, value chains ( and variants such as supply/production chains), life cycle analysis, science and technology studies, policy analysis and labour studies. [↑](#footnote-ref-4)
5. These are energy itself, iron and steel, aluminium, fertiliser and cement, which all contribute to commodities distributed in the informal economy and through informal work. [↑](#footnote-ref-5)
6. The PDS is a centrally administered grain distribution system in India that seeks to ensure that adequate grains are available at a reasonable price across India. [↑](#footnote-ref-6)
7. While we will focus on farming, processing and distribution, we anticipate including fertiliser production in the LCA and interviewing of industry representatives. Emissions from fertiliser production can be gained through LCA databases which we can calibrate in the field. [↑](#footnote-ref-7)