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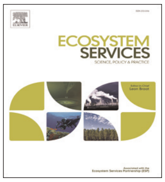

Positive externalities, knowledge exchange and corporate farm extension services; a case study on creating shared value in a water scarce area

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ABSTRACT

Despite much rhetoric about the 'greening business' agenda and various initiatives to promote the valuation of ecosystem services and natural capital, the corporate sector has been slow to integrate social and environmental factors into core business models and to extend this integration across their supply chain. Our effort to narrow this thematic and methodological gap focuses on the co-benefits and positive externalities that can be generated through progressive knowledge exchange between a corporation and its suppliers. Using a case study of contract farming of malting barley in water scarce Rajasthan (India), we examine the extent to which best practice agronomic advice given by corporate farm extension workers can help small scale farmers (suppliers) to increase income, improve resource efficiency (water, fertiliser, energy) and reduce greenhouse gas emissions. Findings from our desk study suggest positive results for all these variables, when compared to the regional benchmark of non-participating farmers. Under a scenario where advice is provided on all major crops (not just barley), we find a significant further increase of farm income. Our valuation of the reduced exploitation of ground water (alone) exceeds the advisors' annual salaries, suggesting that under full social and environmental accounting, the extension services are not a cost factor, but a profit making unit of the company. We discuss of our findings in relation to alternative approaches to PES and alternative investment strategies in green technologies.

1. Introduction

There is a growing effort to involve businesses in the protection of the natural environment and the world's ecosystems, from grand declarations (e.g. the UN 'Natural Capital Declaration'-Mulder et al., 2013) to more practical reports focusing on the quantification and valuation of externalities produced by businesses and the ecosystem services which underpin business performance (World Business Council for Sustainable Development, 2011; TRUCOST and TEEB for Business Coalition, 2013). A company creates externalities when it undertakes activities that bring costs or benefits to unsuspecting third parties. Environmental externalities often relate to impacts on public goods such as clean air or fresh water resources.

Businesses wishing to account for, manage and plan their environmental and social impacts can face a number of challenges, from the lack of established assessment methods to problems along the supply chain where they can exert only partial influence on the behaviour of their suppliers and customers. The nature of relationships along the supply chain has been a focus of media, advocacy and academic attention, showing how a company's brand value can be damaged by revelations about the poor practices of their suppliers (e.g. child labour, environmental pollution, (see Lund-Thomsen and Nadvi, 2010) but also how good environmental and social practices can be promoted amongst suppliers through a pro-active and supportive approach by the larger company that buys their products (e.g. Walton et al., 1998). This paper examines a particular kind of supply chain relationship; between a large company and the many individual farmers supplying its feedstock. Amongst supply chain relations, this particular relationship stands out for the size differential, i.e. a one big buyer with thousands of small suppliers. It also stands out for the fact that farms are not simply businesses; they are families and communities, rooted in a particular agro-ecological landscape and rural culture. The size differential means that companies can have huge leverage on farmers, dictating contracting arrangements that shape farming strategies and thus impact on the rural landscape and the ecosystem services it provides. This leverage may increase

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even further in a developing country context, where farmers tend to have less access to capital, to agronomic advice and (due to poor infrastructure) to different markets and alternative buyers (e.g. Galt, 2007; Porter and Philips-Howard, 1997). Some critical authors have argued that these contract farming arrangements are exposing farmers to new risks, or are causing an unequal distribution of risks and the subordination of farmers (e.g. GoldSmith, 1985; Watts, 1990; Clapp, 1994).

A more progressive outlook would suggest that it is in the long-term interest of the company to think more holistically about their relationship with the farmers. For example gaining farmer loyalty can help to ensure security of supply for their regional processing plants despite the arrival of new buyers on the local market; the provision of training and the supply of farming materials can help to ensure high quality feedstock despite disease outbreaks or adverse weather conditions. Porter and Kramer (2011) flag up several recent examples of corporations benefitting by working more closely and more synergistically with farmers and farmer communities; their call for ‘creating shared value' could be read as a call for creating positive local externalities through company activities that go beyond short-term gain or a singular focus on the short-term bottom line defined exclusively through traditional financial accounting tools. Known as a leading thinker on business strategy, Michael Porter's ideas are evidently having some influence within the business community (for examples in the agricultural sector, see FSG, 2011; Nestle, 2013). The idea of creating shared value differs from corporate social responsibility in that it seeks to anchor pro-social and pro-environmental corporate behaviour within markets and value propositions, rather than within an ‘add-on' narrative of corporate duties and responsibilities. Porter and Kramer list three broad areas where companies should seek to create shared values; (1) rethink products and markets to provide more appropriate services and reach those (poor people) with unmet needs; (2) mitigate risks and improve productivity in the value chain and (3) enable local cluster development, e.g. by supporting suppliers. It is clear that the last two areas can be of direct relevance for contract farming. Also the first area can be relevant for contract farming, in at least two respects. First of all, in developing countries many farmers have unmet information needs, i.e. they require more, better and faster information on technologies, crops, markets, pests or weather in order to make good agronomic and farm management decisions. Secondly, the company's extension workers and logistical operations (e.g. they have empty trucks driving into the countryside to pick up the feedstock) could be seen not just as costs, but as (underutilised) assets that could be deployed for additional business activities, such as the delivery of new and socially beneficial goods and services to remote rural areas[1].

The existing literature on shared value and on the mutual benefits of contract farming is limited in size and is mainly qualitative (Galt, 2007; Porter and Philips-Howard, 1997; Birthal et al., 2008; Porter and Kramer, 2011; Fayet and Vermeulen, 2012; Baumüller et al., 2014; Christiansen, 2014). There is a gap in the literature about the extent to which companies can work progressively with farmers, to reduce the negative environmental externalities of existing farming practices and share the economic benefits of a long term, stable and beneficial interdependence along the supply chain.

In a contribution to narrowing this gap, this paper aims to assess, quantify and value the farming related externalities caused by a company's extension services, using a case study from Rajasthan where small scale farmers were incentivised to start growing malting barley for a company's regional processing plant. It is a case of crop switching on existing agricultural land.

Our paper is structured as follows. In the next section, we provide the business and biophysical context for our case study. We explain the data sources we used and the externalities we have chosen to examine. We develop a set of scenarios which allow us to examine the relative environmental performance of the farmers who grow barley for the company. In the third section we quantify the externalities associated with each scenario. In section four we convert these to monetary values. In section five we discuss the limitations and consequences of our findings, exploring different intervention options to further improve resource efficiency or farmers' incomes. Section six contains our conclusions.

2. Case study background

2.1. Business context

Barley has traditionally been grown in Rajasthan and more widely in northern India as a fodder and feed crop with low input requirements. However over the last 40 years, farmers have shifted from barley towards (higher value) wheat or mustard production (Verma et al., 2010). In 2006 the multinational SABMiller set up the Saanjhi Unnati (Progress through Partnership) project in Rajasthan to develop a local supply chain for barley for their new regional brewery, which would reduce their need to import malting barley from abroad. The company employs 30 agricultural extension workers across Rajasthan who liaise with farmers and sensitize them to the adoption of barley varieties that are more suitable to brewing (notably variety K551, brought in from Uttar Pradesh). Participating farmers receive best practice advice (water management, fertilizer application) to reduce inputs and improve yield. Data was collected by an Indian consultant who was hired by the company to undertake focus group discussions with the extension workers. We obtained the above details and data from discussions with the company, facilitated by the Cambridge Institute for Sustainability Leadership[2].

2.2. Biophysical system

The major crops grown in the Rajasthan region include barley (*Hordeum vulgare* L.), wheat (*Triticum aestivum*), mustard (*Brassica juncea*) and gram (*Cicer arientinum*) grown in the Rabi (winter, dry) season and soybean (*Glycine max*), guar gum (*Cyamopsis tetragonoloba*), bajra millet (*Pennisetum glaucum*) and groundnut (*Arachis hypogaea*) during the Kharif (summer, rainy) season.

This study focuses on the Rabi system and the inputs and outputs produced from this system (table 1); the corresponding ecosystem services and natural capital externalities (table 2). We did not have sufficient data to assess impacts on cultural ecosystem services or on biodiversity. Since this is a case study of crop change on existing fields in an intensely farmed landscape, we anticipate these impacts to be relatively minor. As the study sought to achieve quantification within a business context we focused on externalities where data on inputs and methods to calculate impact/outputs were readily available (Tables 1 and 2), as follows: Water is pumped from wells using diesel and electric pumps, resulting in decline in groundwater reserves and CO_2 production. Inorganic fertilisers (DAP, urea) and organic fertiliser added to the soil result in denitrification of nitrates to N_2O an

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[1] For example Dunavant Cotton use their normal logistical operations to supply mosquito nets in rural Zambia, see http://nwkzambia.com/index.php/mosquito-nets/

[2] This was funded by the Natural Environment Research Council (NERC), under the ‘Valuing Nature Network' http://www.valuing-nature.net. Apart from the use of data that came from company employees, our study is entirely independent.

Table 1 Fertiliser, fuel and water inputs and associated outputs that were assessed in this study.

Inputs to the system	Output	
	Atmospheric	Water
Urea $CO(NH_2)_2$	Green house gas emissions CO_2+Denitrification of nitrogen to N_2O	NO_3 – release of nitrates through runoff and leaching to local water bodies resulting in Eutrophication
DAP (Diammonuim phosphaste) $(NH_4)_2HPO4$	Green house gas emissions N_2O	$NO_3+P_2O_5$ nitrate and phosphates resulting in eutrophication
Organic matter (Animal manure and crops residues)	Green house gas emissions N_2O	$NO_3+P_2O_5$ nitrate and phosphates resulting in eutrophication
Fossil fuels (ground water pumps)	Green house gas emissions CO_2	
Ground water (blue water)		Reduction in water availability and quality. Runoff and leaching resulting in eutrophication
Rain water (green water)		Runoff and leaching resulting in eutrophication

important GHG. Rainfall and irrigation can lead to runoff and leaching of nitrate and phosphate from fertiliser additions leading to eutrophication of local water bodies and a reduction in water quality. This led to carbon balance (green house gases) and water balance (green, blue and grey water) being included (Tables 1 and 2). The addition of crop residues and organic manure leads to an increase in the amount of carbon stored in the soil, while tillage leads to the violation of carbon and release of CO_2. However under the methods applied we found no difference between crops for these externalities. Other outputs such as volatilisation of ammonia and nitric oxide from denitrification were not considered in this study for reasons stated above.

Groundwater extraction by farmers significantly exceeds natural recharge and the current agricultural system is clearly not sustainable in the long term. It is anticipated that the continued depletion of groundwater resources will eventually result in the abandonment of dry season farming ('Rabi' crops are completely dependent on irrigation) and the reduction of yields in the rainy season ('Kharif' crops; currently partially dependent on irrigation).

2.3. *Scenario approach and baseline selection*

The study was implemented on a model farm in the district of Jiapur, Rajasthan, based on an average farm size of 2.8 ha. An assumption is made that 100% of the production area for each crop is irrigated during the Rabi season. While the choice of Rabi crops can influence the choice of Kharif crops, externalities from the Kharif crops are not considered within the study as the company has less influence over this.

We used a scenario approach to estimate change in externalities, taking account of changes in cropping area, crop yield, fertiliser application and ground water levels based on general changes in the agriculture sector and the impact of the company. Four scenarios were developed, a historical pre-company scenario (1) predating the company's establishment in the area (2005–2006) and three present time scenarios (2012–2013). The present time baseline scenario (2) represents farmers NOT working with the company and two present time company scenario representing farmers who draw on the company's extension programme to adopt agronomic best practice with regards to malting barley only (3a), or with regards to malting barley as well as their other their other main crops (3b) (Table 3).

2.3.1. *Proportion of cropping area and yield*

Ministry of Agriculture, Govt. of India district level data was used derive the proportion of cropping area (based on production area data) and yield for the historical and baseline scenarios. SABMiller works with 6000 farmers in Rajasthan, half of them in Jaipur district. Jaipur has a population of over 6.5 million, so it is assumed that the company's activities impact such a small proportion of farmers as to have a negligible effect on the Ministry of Agriculture Jaipur data. This data show year to year variation. To identify general trends in this data a regression model was run to model a line of best fit. The pre-company scenario and no company scenario (baseline) production and yield values were read off this line for the 2005–2006 and 2012–2013 growing seasons respectively.

For the company scenarios (Scenarios 3a and b) values for the yield (see exceptions below) and proportion of cropping area for each were derived from the SABMiller extension worker focus groups. The conservative company scenario 3a assumes that the effects of the extension workers only influence barley yield and not that of the other crops. Therefore the baseline scenario yield values are used again for this scenario for all crops except Barley. While 3b assumes that the SABMiller extension service has an impact on all Rabi crops in the system due to improved management techniques and access to information. The distinction is made between the scenarios (3a and b) as it is assumed that as the farm extension workers who work directly with the farmers on the production and sale of barley will have a greater knowledge of Barley over the other crops (Table 3).

Based on comparisons between the yield data expressed by the focus group studies and the Ministry of Agriculture district level data, differences in yield were found between the baseline and the company scenarios. While these differences are substantial, they are within the 45–70% yield gaps for major crops identified by Mueller et al. (2012).

2.3.2. *Fertiliser application*

The drive for agricultural intensification and fertiliser subsidies has led to an increase in fertiliser applications across India (Sharma, 2012). Rajasthan showed a 26.2% increase in fertiliser use in kg/ha between 2000–2010 (Sharma and Thaker, 2011). Based on this we assume a 13% fertiliser increase between the historical and present time scenarios (Table 3).

Farm extension workers identified agronomic management changes adopted by participating farmers. UREA usage for barley was reduced from 110 kg/ha to 90 kg/ha (Table 3). The extension officers noted that urea added height to the barley plants. These taller plants were more prone to lodging under excess irrigation or rainfall leading to losses and yield reductions.

2.3.3. *Ground water levels*

Based on data on ground water levels in Jaipur and rate of decline (CGWB, 2007), a ground water depth of 30 m is assumed for the historical and 40 m for the baseline and company scenarios (Table 3).

2.3.4. *Barley price*

For barley, the company provides farmers a 5% price premium above the market rate. This is incorporated into the scenarios (Table 3).

Table 2
Ecosystem services associated with inputs/outputs, and data source and methods used for quantification.

Ecosystem service (MEA Category)	Externaility		Units	Method
Regulating	Green house gas emissions	N_2O Urea/DAP/FYM	kg/ha kg/ton	**Method:** emission factor 0.01 IPCC tier 1 guidelines (de Klein et al., 2006) **Data:** Kg/ha of Urea, DAP and FYM derived for extension worker focus groups (Table A1)
		CO_2 ground water pumping	kg/ha kg/ton	**Method:** Emissions 1000 m^3 to 1 m 0.665 kg C – diesel/3.873 kg C electric pumps (Nelson et al., 2009). **Data:** Blue CWU (ground water) derived this study (see below) Ground water level/Well depth (CGWB, 2007)
Regulating (grey) Provisioning	Water consumption/water quality As the water foot printing method is used both are measured in terms of water consumption (m^3).	Green water Blue water	m^3/ha m^3/tonne m^3/ha m^3/tonne	**Method:** Crop evapotranspiration CROPWAT model (Allen et al. 1998) CWU-Hoekstra et al. 2011 **Data:** Kc and LGP (various see Tables A4 and A5 and Bowe et al., 2013). Crop characteristics (FAO, 2009), Soil data (FAO/IIASA/ISRIC/ISSCAS/JRC, 2012))
		Grey water	m^3/ha m^3/tonne	**Method:** Run off and leachate values (Lv et al. 2010; Chapagain and Orr, 2009) **Data:** Kg/ha of Urea, DAP and FYM derived for extension worker focus groups. EU water quality standards (Liu et al. 2012)

2.3.5. *Net farm income*

Net farm income was also estimated for all scenarios. Crop and fodder prices, crop/fodder ratios and cost of production were derived from farm gate prices reported by farm extension worker focus groups (Table A2). Due to the high temporal variability in fodder prices seen in the region likely due to availability of fodder and the localised nature of markets, we also considered data from data from Directorate of Marketing and Inspection (DMI), Ministry of Agriculture, Government of India[3]. Due to the high variability very conservative values were selected. Values up to 10 times greater have been recorded. DAP and Urea costs were adjusted to account for changes in applications in the various scenarios. Extension worker advise led to a reduction in seed rate for barley from 60 kg per acre to 45-55 kg per acre. The effect of this was a small reduction in the cost of production for barley in company scenarios.

3. Quantification of externalities[4]

3.1. *Greenhouse gasses*

IPCC guidelines (de Klein et al., 2006) provided standard conversion factors for determining nitrous oxide (N_2O) emissions based on mineral fertiliser, organic amendments, crop residues and mineralisation for all crops. The amount of synthetic fertilisers (Urea and DAP) and farm yard manure (FYM) applied per hectare of land was provided from the farm extension worker focus groups. The amount of nitrogen applied per hectare was based on its proportion based on molecular weight (Urea 46% ($CO(NH_2)_2$/DAP 18% ($(NH_4)_2HPO4$). This was then multiplied by the conversion factor from de Klein et al. (2006) to estimate level of N_2O emitted (Table 1).

In order to derive the amount of CO_2 produced from pumping up ground water, it was necessary to identify the amount of water applied to the crops, the depth from which it is extracted (see Section 3.2) and the power source for pumping. Values on consumptive water use (CWU) of blue water for each crop were calculated based on Hoekstra et al. (2011) using the CROPWAT modelling software (FAO, 2009) (see Section 3.2). All pumps are assumed to be electric. Nelson et al. (2009) estimated that carbon emissions to lift a 1000 m^3 of water 1 m to be 3.873 kg C with electric pumps (assuming electricity grid transmission losses (5%) and efficiency of electrical and diesel pumps (30%)) (Nelson et al., 2009). The Global warming potential (GWP) index was used to convert all GHG emissions to CO_2e (Lv et al., 2010).

3.2. *Water*

For crop plants, the water foot print or virtual water is mainly determined by evapotranspiration occurring during the timespan between sowing and harvest. While the water applied through rainfall and irrigation may be greater than that evaporated, the water that has percolated into the soil or lost as runoff is not classified as utilised or consumed water, because it will be re-added to the system as groundwater (Schubert, 2011). Water use from effective rainfall (green water) ($CWU^{\text{Effective rain}}$) and from irrigation (blue water) ($CWU^{\text{Irrigation}}$) were estimated based broadly on the Water Footprint Network Standard methods in Hoekstra et al. (2011) using the CROPWAT 8 modelling tool (FAO, 2009). Crop coefficient (Kc) and Length of Growth Period (LGP) values were selected from the scientific literature based on studies conducted in India, in the same agro climatic conditions and varieties mentioned in the extension

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[3] Available at http://agmarknet.nic.in/

[4] Finer details of the quantification of externalities are described in an internal report available from the lead author.

Table 3
Agricultural scenarios for Jaipur.

Scenario	Proportion of crop area (%)				Yield change from Baseline (%)				Barley price change (%)	Inorganic fertiliser application change (%)	Ground water level change
	Barley	Wheat	Gram	Mustard	Barley	Wheat	Gram	Mustard			
Scenario 1 (2005– 2006) Historical-Precompany	14	41	15	30	−15	−19	−22	−22	Current	−13%	−10 m
Scenario 2 (2012–2013) baseline No company	15	36	14	35	0	0	0	0	Current	0	0
Scenario 3a (2012–2013) Company (conservative)	35	30	10	25	+55	0	0	0	Current+5	0 (Barley Only −18% reduction in Urea)	0
Scenario 3b (2012–2013)Company (non conservative)	35	30	10	25	+55	+24	+11	+66	Current+5	0 (Barley Only −18% reduction in Urea)	0

worker survey data as grown in the region (For all study crops no lysismeter studies or local Kc values were identified for Jaipur or even in Rajasthan). Due to the relatively subjective nature of this approach a sensitivity analysis was also conducted using values of Kc and LGP based on a search of the wider literature both in and outside India but in similar agro-climatic zones. Mean and Median values for ETBlue and ETGreen from the sensitivity analysis were found to be close those derived from the selected Kc and LGP (see Bowe et al., 2013 for further details). Values for each crop necessary to calculate the 'irrigation schedule option' (rooting depth, critical depletion fraction and yield response) were derived from appropriate crop files provided with the software (FAO, 2009) or the literature. The CROPWAT soil file was created based on the dominant soil type classification for the Jaipur district Eutric Cambisol derived from the World Harmonised Soil Database (FAO/IIASA/ISRIC/ISSCAS/JRC, 2012).

To allow green water to be incorporated into the valuation (Section 4) we attempted to account for the effect of rainfall on groundwater recharge. To do this an adjusted CWUblue was estimated referred to as "Ground Water Loss". The amount of "rain recharge" was estimated by combining the green water not used and "Total Rain Loss" calculated by CROPWAT. The green water not used is estimated by subtracting the CWUgreen for each crop from the maximum CWUgreen for all crops in the study (in this case mustard). This adjusted CWUBlue or "Ground Water Loss" is calculated by subtracting the "rain recharge" from the blue water (CWUBlue)[5]

To estimate the impacts of water pollution from fertiliser application the concept of grey water is used. The methods used here broadly follow the guidelines for grey water foot printing described in Hoekstra et al. (2011). The nutrient loss rate or pollutant load is the fraction of the total amount of chemicals applied that reaches the groundwater or surface water. The amount of synthetic fertilisers (Urea and DAP) and farm yard manure (FYM) applied per hectare of land was provided from the farm extension worker focus groups. In this case we assume a fixed fraction of the applied chemicals finally reach the ground- or surface water (Hoekstra et al., 2011) 10% of applied nitrogen for nitrate and 1% for phosphate. Grey water consumption is quantified based on the dilution water volumes required to dilute waste flows to such extent that the quality of the water remains below agreed water quality standards (Chapagain et al., 2006; Mekonnen and Hoekstra, 2010). In this case EU standards were selected for both Nitrates (50 mg/l) and Phosphorous (1 mg/l) (Liu et al., 2012).

3.3. *Scenario outputs*

Comparison of the baseline scenario (scenario 2) to the company scenarios (scenarios 3a and 3b) (Table 5); show a reduction in externalities as well as an increase in farm income due to effect of the extension services (Table 4). In comparison to farmers not exposed to SABMiller's extension workers, farmers working with the company have a greater proportion of cropping area under barley and a corresponding smaller proportion under the other crops (wheat (6%), mustard (10%) and gram (4%) less than the baseline scenario-Table 3) along with a reduction in fertiliser application to Barley. This difference is likely due to the availability of high quality barley seeds and extension advice. This has led to a 4% reduction in blue water use (ground water loss), brought about by the greater proportion of cropping area used for barley production, which has the lowest blue water requirements. A 3% reduction is seen in GHG emissions (CO_2e), brought about by the lower energy requirement to pump ground water and the lower nutrient requirements of barley in comparison to wheat and gram. This is also influenced by the change in agronomic management brought about by the company to reduce the amount of UREA applied to Barley. Grey water is also reduced by 1.4% due to the shift from wheat and gram and the decline in fertiliser application to barley. The smaller reduction in the grey water externality in comparison to the other externalities is due to mustard having a slightly lower nitrogen input than barley across the 3 fertiliser types. The increase in farm income seen in the company scenarios has been brought about by the increase in yield due to improved varieties and management practices, good crop and fodder price for barley and the SABMiller premium. The higher income in the non-conservative (3b) scenario is seen due to the assumption that all crop yield are improved due to best agronomic advise by extension workers.

It should be highlighted that the baseline (scenario 2) is subject to the same economic and environmental effect as the company scenario; this provides a robust counterfactual to the impacts of the extension services.

The historical scenario was included to look at the general trends occurring within the agricultural system in Jaipur. Comparison between the historical scenario (scenario 1) and the baseline (scenario 2) indicates a shift from wheat to mustard (and a very small shift to Barley) in the period 2006–2012. This reflects the aggregate behaviour of all farmers in Jaipur, in the absence of the company. As a consequence of this trend, there in a small decline in blue water (ground water loss) (1%) externalities but an increase in GHG (CO_2e) production (24%) and grey water (5%) likely due to the changes in cropping area and the increase in fertiliser use brought about by fertiliser subsidies and intensification. Farm income has increased. The small reduction in blue water use could indicate that farmers are concerned about water use and are moving towards crops that require less irrigation, although

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[5] The finer details of the estimation of water use and sensitivity analysis are described in an internal report, available from the lead author.

Table 4
Results of the scenarios (per 2.8 ha farm).

Scenarios	Crop	CO_2e	CWUBlue	CWUGreen	Ground water loss	GWUGrey	Income	Income+fodder	Cost of production	Net farm income (Rs)
	Kg yr^{-1}					m^3 yr^{-1}			Rs farm $year^{-1}$	
Scenario 1 (historical)	Barley	1076	1658	98	1615	671	12,842	14,065	12,851	1214
	Wheat	3989	6681	344	6613	2074	41,144	45,002	37,719	7283
	Mustard	2507	4116	277	4116	1367	24,948	25,250	15,191	9757
	Gram	1226	1999	134	1991	679	16,254	16,254	7595	8659
	Total	**8798**	**14,455**	**854**	**14,334**	**4791**	**95,188**	**100,571**	**73,355**	**26,913**
Scenario 2 (Current-Baseline)	Barley	1423	1777	105	1730	752	15,347	16,808	13,817	2991
	Wheat	4375	5867	302	5806	1895	42,578	46,570	33,627	12,943
	Mustard	3631	4802	323	4802	1643	35,574	36,005	18,169	17,405
	Gram	1456	1866	125	1858	721	18,542	18,542	7268	11,274
	Total	**10,885**	**14,311**	**856**	**14,197**	**5010**	**112,040**	**117,925**	**72,881**	**44,613**
Scenario 3a (Current-Company–barley advice only)	Barley	3275	4145	245	4038	1674	58,433	63,725	31,478	32,247
	Wheat	3646	4889	252	4838	1579	35,482	38,808	28,022	10,786
	Mustard	2594	3430	231	3430	1173	25,410	25,718	12,978	12,432
	Gram	1040	1333	90	1327	515	13,244	13,244	5191	8053
	Total	**10,555**	**13,797**	**818**	**13,633**	**4941**	**132,568**	**141,495**	**77,669**	**63,517**
Scenario 3b (Current-Company–advice for all crops)	Barley	3275	4145	245	4038	1674	58,433	63,725	31,478	32,247
	Wheat	3646	4889	252	4838	1579	43,008	47,040	28,022	19,018
	Mustard	2594	3430	231	3430	1173	39,270	39,746	12,978	26,292
	Gram	1040	1333	90	1327	515	14,448	14,448	5191	9257
	Total	**10,555**	**13,797**	**818**	**13,633**	**4941**	**155,159**	**164,959**	**77,669**	**86,813**

Table 5
Differences between the scenarios in absolute and relative terms.

Differences between scenarios*	CO_2e output (kg/y/farm)	Groundwater loss (use) (m^3/y/farm)	Grey water (m^3/y/farm)	Farm income (Rs/y/farm)*
Historic (1) to current baseline (2)	+2087 +23.72%	−138 −0.96%	+220 +4.57%	+17700 +65.77%
Current baseline (2) to company (3a; barley advice only)	−330 −3.03%	−563 −3.97%	−69 −1.38%	+18905 +42.37%
Current baseline (2) to company (3b; advice for all crops)	−330 −3.03%	−563 −3.97%	−69 −1.38%	+42200 +94.59%

[*] Only for farm income '+' indicates an improvement.

Table 6
Comparison of company trends to historic trends.

Scenario trends	Change in Increase in CO_2e output %	Reduction in groundwater loss (use) %	Increase in grey water %	Increase in farm income %
Company trend (3a) compared to historic trend (1)	−16%	409	−31	107
Company trend (3b) compared to historic trend (1)	−16%	409	−31	238

they may also be driven by the high value of mustard in comparison to wheat.

The development of the historical scenario allows changes in externalities to be assessed relative to the historic trend for non-participating farmers (Table 6). This indicated that in the period 2006–2013 GHG emissions (CO_2e) and grey water emissions have increased, but these increases are a lower under the company scenario; 16% (GHG emissions) and 31% (grey water) less than what would have happened in the absence of the company. Over this time, there has been a reduction in water use (ground water loss) by farmers, but under the company scenario, that reduction is much bigger (409%) than what would have happened in the absence of the company. There has also been an increase in farm income, but under the company scenarios, that increase has been much higher; 107% (3a) and 238% (3b) higher than would have happened in the absence of the company.

4. Valuation of externalities

4.1. Types of externalities

In valuing the externalities of these different scenarios, we focus mainly on ground water loss, which takes account of blue and green water. We focus on the two water-related externalities mentioned by Rubio and Casino (2001); increased pumping costs and the loss of shallow wells that have dried up. It would also have been possible (as it has been observed elsewhere; see (Reddy, 2005)) to see some reduced agricultural production due to lower groundwater levels, however the reduction in water use is between historic and current scenario is too small to allow us to assume that there has actually been an actual reduction in the area that is under irrigation or yield levels. Hence this is not considered.

4.2. Pumping cost externality

The average farm growing barley for SABMiller is using a total of 13,797 m^3/y of water in irrigation (Table 4). Lifting 1 m^3 of water by 1 m requires 9.534×10^{-3} kWh (assuming a pumping efficiency of 30% and grid losses of 5%; see Nelson et al., 2009), so a drop of 1m of the groundwater table, would require 131.540 kWh extra electricity for pumping up this water. In 2013, domestic consumers were charged a maximum of 5.45 rupees/0.0908$ per kWh in Rajasthan[6] so that 131.540 kWh=$11.94. This annual cost is increasing year on year as the water table drops further. Data from the Rajasthan Groundwater Department (CGWB, 2007) show that groundwater levels are declining across Jaipur. The worst affected agricultural blocks have experienced a drop of 0.7 m/y in the period 1984–2006, 1.4 m/y in the period 2001–2006. In other words groundwater depletion is not just systemic; it is actually accelerating over time. If we assume that groundwater has to be pumped up from 40 m below the surface, then the total electricity costs of pumping amount to $477.6/year/farm, or $0.0346/$m^3$. However, electricity prices are subsidised in India By assuming that consumer prices are only 75% (IISD, 2012, p. 13) of the real cost of production, we arrive at a real cost of $ 0.0433/m^3 of water pumped to the surface.

4.3. Dried wells externality

If x wells are lost in the region as the groundwater level drops by y meter, then the lost well externality can be calculated as:

$((P^*x)/F)/y$ per farm, per m of reduced ground water level,

Where P is the price of a well and F is the number of farms in the region. Since we want to know the lost well externality value of a unit of groundwater that is pumped up, we need to multiply this equation by the annual groundwater level drop (G) and then divide by the amount of water that is over-extracted every year. The latter can be calculated as the average irrigation water use per farm per year (I), divided by the aquifer exploitation rate (R):

$[((P^*x)/F)/y]\ {}^*G/(I/R)$

For Jaipur we used the following values (CGWB, 2007 unless stated otherwise):

P=$1500 (based on costs reported in Reddy, 2005)

x=9463 (these are all the low yield wells in Jaipur–CGWB did not report well depth)

F=316041 (80% of the district is arable[7], which we divided by a farm size of 2.8 ha)

y=10 (we assume that the x wells have all fallen dry over the course of a 10 m groundwater level drop)

G=2.2 m/y (the worst case figures in 2004, we assumed them to be common now)

I=14455 m^3/y (from the cropwat model)

R=2 (i.e. 200%-we took an upward figure from the 2004 exploitation rate of 186%)

This gives us a marginal dry well externality of $0.00138/$m^3$ based on shallow wells that we assume have largely fallen dry already. This is small amount masks a very uneven distribution: farmers who have no shallow wells lose nothing whilst those who do have such a shallow well, have lost $1500. These are also the farmers who are least likely to be extracting lots of water.

The value of the marginal dry well externality is 31 × smaller than that of the marginal pumping cost externality. Together, the two water over-extraction externalities amount to $0.0447/$m^3$ (i.e. 4.5 dollar cent).

4.4. Aggregating the externality values across the whole extension programme

On an annual basis, a farmer growing malting barley uses 563 m^3 water less than the baseline (the non participating farmers). Hence a single company contracted farm avoids water extraction externalities worth $25.38/y. Over the 6000 farms involved in the program this creates a reduction of water use of 3,414,000 m^3/y (3.4 km^3), which amounts to a total of avoided water extraction externalities of $152,280/year. With 30 farm advisors employed by the company, and an annual salary per farm advisor estimated to be $5000/y, the value of the avoid water extraction externalities exceeds their annual salary. [8]

The program wide reduction of CO_2 emissions can be calculated as 6000 × 330 kg/y=1980 tCO_2/y. There are some very wide ranging views on the 'right' price for carbon (for a literature review, see Tol, 2010). The faltering EU Emissions Trading Scheme has seen carbon trade slumping from a high of 35 to 5 Euro/tonne in recent years, whereas Sweden has wielded a carbon tax in excess of $100/tonne for some sectors of its economy. In short, it is not possible to pick a 'robust' price for carbon. However, just for the sake of comparison, we could ask at what price would carbon be a comparable externality to water for our case study? A carbon price of $75/$tCO_2$ would put the total carbon emissions reduction at $150 k and the combined water and carbon savings at $300 k for the 6000 farms participating in the barley growing programme. A price of $75/$tCO_2$ is quite high, but not extreme (for higher values see Stern, 2007 and DECC, 2009).

5. Discussion

In this study we have identified, quantified and valued positive externalities that could be produced when corporate farm extension workers provide farmers with best practice agronomic advice. For all its limitations as a desk-study, we would argue that our analysis is clearly novel and insightful, in a number of respects.

First of all it illustrates that explorative studies can be carried out with limited resources, i.e. we were able to draw on existing secondary data from various on-line sources and bottom-up information that is in principle already available within the company, namely the knowledge and experience of extension workers who spend much of their time in the field with farmers. Independent verification through interviews with (participating and non-participating) farmers is an important limitation of the current study, and a pointer for future research. We also recognise that other case studies may have to address more externalities and a greater range of ecosystem services, especially if the landscape is more diverse in habitats and gradients, and if the company's intervention results in the extension

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[6] Price obtained at http://www.bijlibachao.com/Calculators/online-electricity-bill-calculator-for-all-states-in-india.html

[7] http://agricoop.nic.in/Agriculture%20contingency%20Plan/Rajasthan/RAJ1-Jaipur%203.2.2011.pdf

[8] We don't know what SABMiller pay their staff, but the usual salaries of farm advisors (graduates in agriculture) in Rajasthan working for NGOs and Indian companies, are in the region of $2000–$5000 per annum, dependent on experience and excluding travel allowance (information provided by job adverts and verified by mr Meghwanshi, a Rajasthani agricultural expert).

of the arable area and other displacement effects.

Our scenarios include not just a counterfactual for a snap-shot comparison between participating and non-participating farmers, but (importantly) also a historic comparison, which helps us to understand the on-going trends within the regional agricultural system. This reveals that in recent years there has been further agricultural intensification in terms of fertiliser use but not in terms of water use, which has shown a small reduction. Combined with the observed crop shifts, this would seem to point towards water becoming a more constraining factor, despite irrigation being so widespread and under-priced. Our method to value water extraction externalities is noteworthy as a pragmatic approach that illustrates how existing regional water reports and well surveys can be utilised to estimate a generic damage function.

What is perhaps most notable in our findings, is the significant further improvement in farm profitability which extension workers can help farmers to achieve, if they go beyond the promotion of best practice agronomic advice for the feedstock crop for the company (malting barley) and advise farmers on all their major crops. Our study opens up a number of interesting questions. Given its potential to significantly increase farmer income, could farmer advice serve as an alternative to payments for ecosystem services (PES) schemes? In other words, to what extent would be possible to entice farmers with improved income through targeted agronomic advice, to undertake more farm management changes that will better safeguard natural capital or ecosystem services? Secondly, to what extent could a progressive contract farming scheme be designed in such a way that part of the increase in farmer income is invested in more sustainable technologies, thus further reducing the negative impacts of farming on the environment?

One logical future option would be to provide best practice agronomic advice on the least thirsty crops, under an agreement that would see a reduction in the planting of the most thirsty crops or the uptake of drip-irrigation. This would imply a strategic rethinking of the role of the farm advisors within the company, which could be expanded from facilitators of feedstock production for the company, to the more holistic remit of becoming farm sustainability advisors. There would be cost implications for the company; expanded training for the advisors, paying their salaries when they are spending more time on farms providing advise, monitoring their effectiveness. However there may also be various alternative options for funding this, ranging from partnership working with environmental NGOs who may want to support the adoption of sustainable farming innovations or activities to improve rural livelihoods, or the ministry of agriculture that is struggling to afford a full farm extension service and might consider sub-contracting certain activities to a company that already has employees on the ground and a regional transport and communication infrastructure in place. Last but not least, a full accounting of social and environmental externalities by the company will allow these extra costs to be compared with the extra benefits that farm advisors produce. Our estimate that the positive water externalities alone already exceed the farm advisors' salaries, would suggest that under full social and environmental accounting, the farm advisory arm of the company can be generating significant positive returns by extending their remit to providing ‘whole farm' sustainability advise (as opposed to single crop advice). In other words, farm advisors may in the past have been seen as just a cost factor but our research shows that they can play a key role in creating shared value.

By implication this paper also throws up questions about the rationale for investment and supply chain management decisions by the company. For example, why did they set up a contract farming operation for locally grown malting barley, rather than continuing to import good quality malting barley from abroad, or purchasing barley that is already traded on the Indian market? We do not have independently verifiable information on such decisions, which are often hidden behind business confidentiality. It is easy to identify potential motivations, e.g. local production may be cheaper, combining local production with purchases on the open market is a way to reduce the risk of supply chain interruptions or risk of exposure to unfavourable currency exchange rates (the beer is sold for rupees on the indian market; imported barley is paid for in foreign currency). Investing in a local supply chain may be a tool for building political capital, which is useful when dealing with the various regulators. It may create new marketing opportunities (e.g. Indian beer made with Indian barley). In short, there are a number of non-environmental reasons why the company may have decided to invest in this local supply chain. The reduction in groundwater use, is likely to be an accidental positive outcome of that business decision.

As a final point of discussion, despite positive marginal change at the farm level it is important to recognise that the unsustainable depletion of the aquifer is so great that it is very unlikely that it could be fully resolved by extension services alone (provided by the state, targeting all farmers, never mind private extension services targeting some farmers). A collaborative and coordinated approach is required across the entire watershed, involving all significant water users, with investments being made not just to reduce groundwater use but also to increase capture and retention of rainwater. The tragedy of groundwater commons is widely recognised, but it could be argued that there is much more scope for corporations to act as facilitators and lead-stakeholders in initiating, formulating and implementing collaborative management agreements in developing countries. After all, multinational companies are significant regional investors with highly visible assets on the ground and with a wealth of in-house environmental expertise due to the fact that they also operate in markets where environmental regulations are more elaborate and stringent.

6. Conclusions

As a novel contribution to research on creating shared value, and the role of corporations in maintaining natural capital and regional ecosystem services, this paper set out to examine the extent to which a company depending on regional farmer-produced feedstock, can help create positive environmental externalities in the farming system by providing participating farmers with best practice agricultural advice through their agricultural extension services.

In a case study which involved a crop change on some of the farmers' fields within an existing arable landscape, and we have focused on two externalities which we believed to be most important in this case, namely greenhouse gas emissions and groundwater abstraction for irrigation. The latter is of great importance in the case study area, semi arid Rajasthan, due to the continued overexploitation of the aquifer. The dropping water tables affect all farmers, but especially poorer farmers who cannot afford to drill deeper wells.

Our analysis has shown that farm extension services can help to produce significant environmental benefits and increased farmer income. Having assessed, quantified and valued greenhouse gas emissions reductions and reductions in ground water use, we found that under the current company scenario, the value of these positive externalities is already sufficiently large that it exceeds the costs of running the farming extension service. Although these positive environmental impacts may be accidental by-products of a commercial decision to diversify supply options, it should open the door for more progressive thinking within companies about the role and value of their existing extension services, and how to make the most of them.

We have discussed a scenario in which farm advisors do not just provide agronomic advice on barley (which the company buys) but on all the other crops grown by the farmer and sold to other customers. Under this farmer-optimal scenario, farmers' incomes show a significant further growth without affecting the reductions of greenhouse gas emissions and groundwater use already achieved by the current company scenario.

Further research would be needed to examine how this farmer-optimal scenario could be pursued without the risk of a rebound effect (e.g. farmers using their increased income to buy stronger pumps) but with farmers reinvesting some of their increased income in green technologies which can further reduce their dependence on, and use of, ground water or fossil fuels. Such research would not be possible without both the farmers' and the company's active collaboration. As the logical go-between, a strong

Table A1
Baseline scenario values for fertiliser application. All derived from extension worker focus groups.

Crop	Barley	Wheat	Mustard	Gram
Urea application (kg ha^{-1})	110	100	50	344
DAP application (kg ha^{-1})	100	100	100	185
Organic fertiliser application (kg ha^{-1})	22,239	24,711	24,711	2670

Table A2
Crop yields for all scenarios and fodder crop ratios.

Crop	Barley	Wheat	Mustard	Gram	Derived from
Crop yield baseline scenario 2 (tons ha $^{-1}$)	2.9	3.3	1.1	1.1	Ministry of Agriculture, Govt. of India – Jiapur district data
Crop yield historical scenario 1 (tons ha $^{-1}$)	2.6	2.8	0.9	0.9	Ministry of Agriculture, Govt. of India – Jiapur district data
Crop yield company scenarios 3a and 3b (tons ha $-^{1}$)	4.5	3.3 (4)	1.1 (1.7)	1.1 (1.2)	Extension worker focus groups
Fodder/yield ratio	1.5	2	2	0	Extension worker focus groups

Values in parentheses only non-conservative company scenario (3b)

Table A3
Crop and fodder prices and cost of production.

Crop	Barley	Wheat	Mustard	Gram	Derived from
Crop Price (Rs ton^{-1})	12,600	12,800	33,000	43,000	Extension worker focus groups
Fodder price (Rs ton^{-1})	800	600	200	0	Extension worker focus groups and Directorate of Marketing & Inspection (DMI), Ministry of Agriculture, Government of India
Cost of production (Rs ton^{-1})	32,898	33,360	18,540	29,650	Extension worker focus groups

Table A4
Source for Kc values selected and rational.

Crop	**Source**	**Rational for selection**
Barley	Sabu et al. 2000	Study area in Pujab, India—same agroclimatic zone as study site (semi-arid)
Wheat	Tyagi et al. 2000	Study area Haryana, India—same agroclimatic zone as study site (semi- arid). Study Variety HD 2329 grown in Jaipur
Mustard	Sabu et al. 2000	Study area in Pujab, India—same agroclimatic zone as study site
Gram	Sabu et al. 2000	Study area in Pujab, India—same agroclimatic zone as study site

Table A5
Selected Length of growing period and Crop coefficients.

Crop	**Length of growing periods (days)**						**Crop coefficients in growth periods (Kc)**			
	Sowing date*	Initial	Development	Mid-season	Late season	Total	Initial	Development	Mid-season	Late season
Barley	*10/11*	15	25	50	30	120	0.34	0.69	1.05	0.65
Wheat	20/11	16	27	54	33	130	0.5	1.36	1.24	0.42
Mustard	15/10	15	45	65	25	150	0.34	0.61	0.88	0.82
Gram	15/10	23	47	52	28	150	0.26	0.63	1	0.63

* Sowing date derived from Extension worker focus groups.

and progressively minded agricultural extension service could be vital in creating a shared value approach, providing an important step in shifting the company towards a more pro-active, constructive and collaborative role in engaging with water scarcity, ecosystem degradation and other important environmental challenges of the 21st century.

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Appendix A

See Tables A1–A5

References

Allen, R.G., Pereira, L.S., Raes, D., Smith, M., 1998. Crop Evapotranspiration: Guidelines for Computing Crop Water Requirements. FAO Irrigation and Drainage Paper, vol. 56. Food and Agriculture Organization, Rome, Italy.

Birthal, P.S., Jha, A.K., Tiongco, M.M., Narrod, C., 2008. A case study of smallholder dairying in India improving farm-to-market linkages through contract farming. IFPRI Discussion Paper 00814. Markets, Trade and Institutions Division.

Baumüller, H., Husmann, C., von Braun, J., 2014. Innovative business approaches for the reduction of extreme poverty and marginality?. In: von Braun, J., Gatzweiler, F.W. (Eds.), Marginality Addressing the Nexus of Poverty, Exclusion and Ecology. Springer, Dordrecht Heidelberg New York London, ISBN: 978-94-007-7060-7http://dx.doi.org/10.1007/978-94-007-7061-4, ISBN 978-94-007-7061-4 (eBook).

Bowe, C., van der Horst, D, Meghwanhi, C., 2013. Assessing Externalities of SABMiller's Barley Extension Program.

Christiansen, N., 2014. Business initiatives that overcome rural poverty and marginality through creating shared value. In: von Braun, J., Gatzweiler, F.W. (Eds.), Marginality Addressing the Nexus of Poverty, Exclusion and Ecology. Springer, Dordrecht Heidelberg New York London, ISBN: 978-94-007-7060-7http://dx.doi.org/10.1007/978-94-007-7061-4, ISBN 978-94-007-7061-4 (eBook).

CGWB, 2007. Ground Water Scenario Jaipur District, Rajasthan. Ministry of Water Resources, India. Central Groundwater Board. Cgwb.gov.in/district_profile/Rajasthan/Jaipur.pdf.

Chapagain, A.K., Orr, S., 2009. An improved water footprint methodology linking global consumption to local water resources: a case of Spanish tomatoes. J. Environ. Manag. 90, 1219–1228. http://dx.doi.org/10.1016/j.jenvman.2008.06.006.

Chapagain, A.K., Hoekstra, A.Y., Savenije, H.H.G., Gautam, R., 2006. The water footprint of cotton consumption: an assessment of the impact of worldwide consumption of cotton products on the water resources in the cotton producing countries. Ecol. Econ. 60 (1), 186–203. http://dx.doi.org/10.1016/j.ecolecon.2005.11.027.

Clapp, R.A., 1994. The moral economy of the contract. In: Little, P.D., Watts, M.J. (Eds.), Living Under Contract. University of Wisconsin Press. DECC, Madison, WI 2009. Carbon valuation in UK policy appraisal: a revised approach. Department of Energy and Climate Change, United Kingdom.

de Klein, C.A.M., Novoa, R.S.A., Ogle, S., Smith, K.A., Rochette, P., Wirth, T.C., McConkey, B.G., Mosier, A., Rypdal, K., 2006. N_2O emissions from managed soils, and CO_2 emissions from lime and urea application. In: Eggleston, S., Buendia, L., Mwia, K., Ngara, T., Tanabe, K. (Eds.), 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Agriculture, Forestry and Other Land Use., Vol. 4. IPCC, Kanagwa, Japan

FAO, 2009. CROPWAT 8 FAO Water Resources. Development and Management Service.

Fayet, L., Vermeulen, W.J.V., 2012. Supporting Smallholders to access sustainable supply chains: lessons from the indian cotton supply chain. Sust. Dev. . http://dx.doi.org/10.1002/sd.1540

FSG, 2011. Creating Shared Value in India: How Indian Corporations are Contributing to Inclusive Growth while Strengthening their Competitive Advantage ⟨www.fsg.org⟩.

Galt, R.E., 2007. Regulatory risk and farmers' caution with pesticides in Costa Rica. Trans. Inst. Br. Geogr. 32 (3), 377–394. http://dx.doi.org/10.1111/j.1475-5661.2007.00256.x.

GoldSmith, A., 1985. The private sector and rural development: can agribusiness help the small farmer. World Dev. 13 (11/12), 1125–1138. http://dx.doi.org/10.1016/0305-750X(85)90031-2.

Hoekstra, A.Y., Chapagain, A.K., Aldaya, M.M., Mekonnen, M.M., 2011. The Water Footprint Assessment Manual: Setting the Global Standard. Earthscan, London, UK.

IISD, 2012. A Citizen's Guide to Energy Subsidies in India Report produced by the Energy and Resources Institute (TERI) and the International Institute for Sustainable Development (IISD).

Liu, C., Kroeze, C., Hoekstra, A.Y., Gerbens-Leenes, W., 2012. Past and future trends in grey water footprints of anthropogenic nitrogen and phosphorus inputs to major world rivers. Ecol. Indic. 18, 42–49. http://dx.doi.org/10.1016/j.ecolind.2011.10.005.

Lund-Thomsen, P., Nadvi, K., 2010. Global value chains, local collective action and corporate social responsibility: a review of empirical evidence. Bus. Strat. Environ. 19 (1), 1–13.

Lv, Y., Gu, S., Guo, D., 2010. Valuing environmental externalities from rice–wheat farming in the lower reaches of the Yangtze River. Ecological Economics 69, 1436–1442. http://dx.doi.org/10.1016/j.ecolecon.2008.12.014.

Mekonnen, M.M., Hoekstra, A.Y., 2010. A global and high-resolution assessment of the green, blue and grey water footprint of wheat. Hydrol. Earth Syst. Sci. 14 (7), 1259–1276. http://dx.doi.org/10.5194/hess-14-1259-2010.

Mueller, N.D., Gerber, S.J., Johnston, M., Ray, D.K., Ramankutty, N., Foley, J.A., 2012. Closing yield gaps through nutrient and water management. Nature 490, 254–257. http://dx.doi.org/10.1038/nature11420.

Mulder, I., Mitchell, A.W., Peirao, P., Habtegaber, K., Cruickshank, P., Scott, G., Meneses, L., 2013. The NCD Roadmap: Implementing the Four Commitments of the Natural Capital Declaration. UNEP Finance Initiative: Geneva and Global Canopy Programme, Oxford.

Nelson, G.C., Robertson, R., Msangi, S., Zhu, T., Liao, X., Jawajar, P., 2009. Greenhouse gas mitigation issues for Indian Agriculture. Environment and Production Technology Division IFPRI. Discussion Paper 00900.

Nestle, Nestle in Society, 2013. Creating Shared Value and Meeting Our Commitments.

Porter, M.E., Kramer, M.R., 2011. Creating Shared Value. Harvard Business Review.

Porter, G., Philips-Howard, K., 1997. Comparing contracts: an evaluation of contract farming schemes in Africa. World Dev. 25 (2), 227–238. http://dx.doi.org/10.1016/S0305-750X(96)00101-5.

Reddy, V.R., 2005. Cost of resource depletion externalities: a study of groundwater overexploitation in Andhra Pradesh, India. Environ. Dev. Econ. 10, 533–556. http://dx.doi.org/10.1017/S1355770 × 05002329.

Rubio, S.J., Casino, B., 2001. Competitive versus efficient extraction of common property resources: the groundwater case. J. Econ. Dyn. Control 25, 117–1137.

Schubert, H., 2011. The virtual water and the water footprint concepts. acatech MATERIALIEN – NR 14 Statements of the acatech project group “Georessource Wasser–Herausforderung Globaler Wandel”.

Sharma, P.V., Thaker, H., 2011. Demand for Fertiliser in India: Determinants and Outlook for 2020. Indian Institute of Management, Ahmedabad, India, April 2011.

Sharma, P.V., 2012. Dismantling Fertiliser Subsidies in India: Some Issues and Concerns for Farm Sector Growth. Indian Institute of Management, Ahmedabad, India, September 2012.

Stern, N.H., 2007. The Economics of Climate Change: the Stern review.. Cambridge University Press.

Tol, R.S.J., 2010. The economic impact of climate change. Perspekt. Wiss. Polit. 11 (1), 13–37.

TRUCOST and TEEB for Business Coalition, 2013. Natural Capital at Risk. The top 100 Externalities of Business 2013.

Verma, R.P.S., Sarkar, B., Mishra, B., April 5–10, 2010. Improvement of two-row malt barley through two- × six-row hybridization in India. In: Ceccarelli, S., Grando, S. (Eds.), Proceedings of the 10th International Barley Genetics Symposium, 2008. Alexandria, Egypt. ICARDA Aleppo, Syria, PO Box 5466.

Walton, S.V., Handfield, R.B., Meinyk, S.A., 1998. The green supply chain: integrating suppliers into environmental management processes. Int. J. Purch. Mater. Manag. 34 (1), 2–11.

Watts, M., 1990. Peasant under contract: agro-food complexities in the third world. In: Bernstine, H., et al. (Eds.), The Food Questions. Profit versus People Earthscan Publications Ltd, London.

World Business Council for Sustainable Development, April 2011. Guide to Corporate Ecosystem Evaluation—A framework for Improving Corporate Decision-Making. Copyright© World Business Council for Sustainable Development.