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Improving environmental practices in agricultural supply chains: The role of company-led standards

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ABSTRACT

Food retailers and manufacturers are increasingly committing to address agricultural sustainability issues in their supply chains. In place of using established eco-certifications, many companies define their own supply chain sustainability standards. Scholars remain divided on whether we should expect such company-led programs to affect change. We use a major food retailer as a critical case to evaluate the effectiveness of a company-led supply chain standard in improving environmental farm management practices. We find that the company-led standard increases the adoption of most environmental best management practices among the company's fruit, vegetable and flower growers in South Africa. This result is robust across two identification strategies: a panel analysis of over 950 farm audits and a cross-sectional matching analysis using original survey data. In-depth interviews suggest that the program's unique focus on capacity building through audit visits by highly trained staff, coupled with a close business relationship between the retailer and their growers help to explain the increased effectiveness of the program as compared to other private environmental standards. Contrary to the argument that company-led initiatives are mere window dressing, this study provides a critical example of the positive role private governance mechanisms can play in improving environmental farm management practices globally.

1. Introduction

Firms are increasingly being called to take responsibility for the social and environmental impacts of their operations, as exhibited by the inclusion of the private sector as a key partner in reaching the United Nations' Sustainable Development Goals. Yet often, the largest environmental impacts of a company's operations are concentrated in the raw material production (Roy et al., 2009). Agriculture alone represents upwards of 30% of our planet's greenhouse gas emissions, has led to expansive dead zones from nitrogen runoff, and is one of the primary drivers of deforestation (Foley et al., 2011; Gibbs et al., 2010; Henders et al., 2015).

Companies have committed to ameliorate the social and environmental impacts of their own operations as part of their corporate social responsibility (CSR) strategies for many years (Dauvergne and Lister, 2013; Vogel, 2005). Yet it is only in the last two decades that food retailers and manufacturers have begun to engage deeply around issues of sustainability in their supply chains. This rise in private and hybrid governance of environmental issues has been well documented in the literature (Beghin et al., 2015; Lemos and Agrawal, 2006; Newell et al., 2012; Waldman and Kerr, 2014). For example, Unilever has committed to 100% sustainably sourced raw materials by 2020, while Hershey promises to only use third-party certified sustainable cocoa in the same time period (Unilever, 2016; The Hershey Company, 2016). Green (2014) estimates that 90% of private environmental standards have been introduced since 1990, with the majority in the food and textile sectors.

A variety of tools have emerged to address environmental governance in supply chains, ranging from individual firm efforts to non-government organization (NGO)-led certification and industry standards (Auld et al., 2008). Among these approaches, NGO and multi-stakeholder certification schemes, such as FairTrade or the Forest Stewardship Council, are the most frequently studied (DeFries et al., 2017; Rueda et al., 2017; Tallontire, 2007). But supply chain standards developed by individual companies are the most commonly used sustainable sourcing strategy firms employ to deal with social and environmental issues (Barrientos and Smith, 2007; Lee et al., 2012; Miller, 2015). In 2008, over 90% of the world's top 250 businesses employed a

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company-led standard to regulate their suppliers' behaviors (KPMG International, 2008). Individual company supply chain standards (henceforth referred to as 'company-led standards') are set by individual companies to address social and/or environmental practices of their suppliers and can be monitored by first, second or third party actors.[1]

Understanding company-led standards' impact on improving environmental practices in agriculture supply chains is necessary both because of their prevalence, but also because of tension over whether or not such company-directed efforts can drive real change in supplier practices. Some scholars argue that company-led standards implemented by powerful firms are capable of influencing suppliers' practices as often suppliers are dependent on the lead firm for business (Andersen and Skjoett-Larsen, 2009; Mayer and Gereffi, 2010). For example, buying firms can encourage their suppliers' compliance through volume or price incentives or threats to terminate contracts (Porteous et al., 2015). In contrast, there is concern by some actors that company-led standards will not be effective because, by companies' profit-maximizing nature, they are not incentivized to ensure their environmental commitments are translated into change on the ground (Elder et al., 2014). Instead, these standards are used either as mere window dressing by companies (Alves, 2009; Delmas and Burbano, 2011) or to avoid more stringent government regulation or negative publicity that could harm their reputation (Baron, 2001; Khanna and Brouhle, 2009; Segerson, 2013). As governments, civil society and consumers increasingly rely on companies for assurance of sustainable natural resource use, it is necessary to better understand if such company-led initiatives are delivering the impact they purport to achieve (Chaplin-Kramer et al., 2015; Miller, 2015).

To date, there has been very limited empirical evidence of the impact of company-led standards on environmental practices, particularly in the agri-food space (Beghin et al., 2015; Fuchs and Kalfagianni, 2010). A few studies have examined company-led standards' impact on social issues, primarily in textile supply chains (Distelhorst et al., 2015; Frenkel and Scott, 2002; Locke, 2013b). Of the limited studies in the agri-food space, Ruben and Zuniga (2011) find that Starbuck's CAFÉ program increases the uptake of good agricultural practices as compared to an NGO-led certification scheme. A qualitative study of Walmart's Direct Farm program in Nicaragua questions the benefits of the company's sustainability program in improving good agriculture practice uptake (Elder and Dauvergne, 2015). Expanding to industry-led initiatives, Lockie et al. (2014) find that adherence to GlobalGAP certification does not increase producers' adherence to national environmental laws in the Philippines. Similarly, Mengistie et al. (2017) find no significant effect of industry and NGO-led certification schemes on horticulture farms' adoption of environmental practices in Kenya.

In contrast, there is a stronger literature in the agri-food space on the effectiveness of multi-stakeholder and NGO-led certification schemes on promoting environmental practices (Blackman and Rivera, 2011; DeFries et al., 2017; Waldman and Kerr, 2014). A number of rigorous studies suggest that Rainforest Alliance or organic standards improve the adoption of environmental best management practices among farmers (Blackman and Naranjo, 2012; Ibanez and Blackman, 2016; Rueda et al., 2014). In contrast, DeFries et al. (2017)'s meta-study of voluntary certification's effect on small-holder producers find that only 36% of environmental response variables improve with certification. These studies suggest that standard-based programs created by credible third parties can have some effect on the adoption of environmental management practices, but results vary by context.

Our paper contributes to the gap of rigorous empirical analyses of company-led programs by examining how Woolworths Holding Ltd.'s (Woolworths) supply chain standard affects the uptake of environmental best management practices among their fruit, vegetable and flower growers in South Africa. We use quantitative evidence from two identification strategies. First, we conduct a panel analysis of the program's impact using over 950 third-party audits across 228 farms and seven years. Second, we draw on an original cross-sectional survey of treated and control farms, where control farms are subject to an industry-led environmental standard. Finally, we conducted over 90 in-depth interviews with farmers, auditors and Woolworths staff to corroborate our findings and explore the mechanisms by which the program affects change.

In the ideal research case, we would link the adoption of best management practices observed in this study to the environmental outcomes of interest (soil erosion levels, reduced nitrogen load in waterways, etc.). However, due to the cost, complexity and scale of projects required to detect changes in landscape-level environmental outcomes, we use the adoption of best management practice as an early indicator of improved environmental outcomes (Bockstaller et al., 1997; Holland, 2004). In particular, we focus on environmental best management practices relevant to South Africa's most pressing environmental challenges, including water scarcity, invasive species management and soil erosion (Blignaut et al., 2009; Goldblatt, 2011).

We chose the Woolworths' program as a potential critical case among company-led supply chain standards. A critical case is one in which the outcome of interest is expected to be most (or least) likely to occur (Flyvbjerg, 2006; Yin, 2013). In short, if the Woolworths program does not create change among farmers, it is less likely that we will observe changes in less robust company-led standards. By studying a critical case, our findings can help to inform the myriad other company-led standards in reaching their pronounced goals of improving environmental management of key natural resources.

This study contributes to better understanding private environmental governance in a number of ways. First, company-led standards are rarely studied, likely in part due to the proprietary nature of much of this information (Beghin et al., 2015; Chaplin-Kramer et al., 2015). Second, our panel analysis of 228 farms using both farm and time period fixed effects allows us to remove the confounding effects of time invariant unobserved factors and common shocks, thereby addressing many of the methodological shortcomings of cross-sectional analyses commonly used for impact evaluation (Angrist and Pischke, 2009; Blackman and Rivera, 2011). Third, we examine changes in specific environmental practices among farmers. Many studies only examine changes in summary environmental scores among suppliers, making it difficult to assess the potential impact on specific environmental practices (Distelhorst et al., 2016; Short et al., 2016). Finally, we move beyond the binary question of effectiveness to examine the mechanisms by which Woolworths' company-led standard drives change among farmers.

2. Study description

Woolworths Holdings, Ltd. is a high-end grocery and clothing chain based in South Africa and is one of the five largest retailers in the country (Piatti and Shand, 2015). In 2009, Woolworths launched a company-led standard program, Farming for the Future (FFF), to improve the environmental practices of the fruit, vegetable and flower farms that they source from. The goal of the FFF program is to "radically improve soil and plant health, preserve resources like water and soil and protect biodiversity" (Woolworths Holdings Ltd, 2009). Woolworths developed the standards in collaboration with a third-party environmental consulting firm, with feedback from farmers and the non-governmental organization WWF-South Africa. The FFF program provides a baseline evaluation and annual third-party audits of farming practices. Each year, farmers receive an audit score and recommendations to improve farm management practices by trained third-party agronomists and environmental scientists. All growers are required to enroll in the program and are expected to show continuous

[1] First party audits refer to self-audits conducted by the supplier; second-party audits are conducted by the buying firm; third-party audits are conducted by an external party.

improvement in order to supply Woolworths. However, due to budget constraints, the program was phased in over the last eight years. As of 2016, the FFF program covered 100% of primary growers and 65% of secondary growers.[2] Woolworths does not provide any price premium or other financial incentive for involvement in the program, but they do cover the costs of the FFF audits.

We argue that the FFF program has attributes of a critical case among company-led standards because it: (a) includes rigorous environmental standards, (b) relies on third-party auditing, and (c) is implemented in a direct supply chain by a retailer with significant market share. In their review of the literature, Waldman and Kerr (2014) highlights these characteristics as key elements of effective private governance systems. We describe the theoretical underpinnings to this selection in Section 3.

Any private standard is necessarily embedded in the wider policy and socioeconomic contexts of the region (Lambin et al., 2014). Although many agricultural supply chains span country borders, we constrain our study to South African farms to avoid potential influences of heterogeneous national regulations, which have been shown to significantly influence the effectiveness of private regulations (Distelhorst et al., 2015; Hugill et al., 2016). South African agriculture is subject to many environmental regulations, particularly around invasive species management, hazardous waste disposal and water use (Department of Environmental Affairs and Tourism, 1998; Hönke et al., 2008). However, due to capacity constraints, government environmental regulations are rarely enforced (Hönke et al., 2008).

3. Theory

Many scholars highlight the need to develop a nuanced understanding of the mechanisms by which private governance systems might influence suppliers' behaviors (Hugill et al., 2016; Tampe, 2016). Any given standard includes several components that may impact its effectiveness, including who sets the standard, the type of monitoring, the enforcement mechanism and the relationship between buyer and supplier. Below, we examine how we might expect company-led standards to influence supplier practices based on existing literature.

Who sets the standard: Many argue that companies use supply chain standards primarily to protect them from reputation damage (Bartley, 2005; Dauvergne and Lister, 2012; Vogel, 2010). Given that there is almost no accountability of company-led standards, companies have little incentive to ensure the programs they have in place actually drive change (Baron, 2001; Hoang and Jones, 2012; Rueda et al., 2017). From this perspective, we would expect company-led standards to have very limited effects on improving practices.

Other evidence suggests that companies use standards primarily to protect them from legal liability of suppliers' poor conduct (Chen and Lee, 2015; Fulponi, 2006; Snir, 2009). For example, Fulponi's interviews with lead food retail firms found over two-thirds of firms were interested in the legal protection standards provide (Fulponi, 2006). If companies are concerned with the potential legal liability of suppliers' poor conduct, we would expect companies to implement standards focused on legal compliance against existing regulations.

Monitoring: Most standards rely on audit visits to identify non-confirming suppliers. Yet because of the need to standardize information, audits have been shown to be most effective in addressing *technical* requirements such as clearly signed exit doors or ensuring policies are in place that are easily verified through a visual inspection or documentation checks (Barrientos and Smith, 2007; Locke et al., 2009). In contrast, the audit process is less equipped to detect or properly remediate *fundamental* violations to social or environmental codes, such as labor right violations or other major shifts to management practices (LeBaron and Lister, 2015). Locke (2013a) argues that audits cannot be expected to change fundamental behavior if the buyer does not support suppliers in changing practices. Instead, the audit process often results in suppliers gaming the audit system to avoid making significant changes through falsifying documents, hiding operations, etc. (Coslovsky and Locke, 2013; Hoang and Jones, 2012). We use the distinction of *legal*, *technical* and *fundamental* practices to examine how the FFF program influences different types of management practices.

Enforcement: One of the key assumptions of the standards-based approach is that buyers working with negligent firms will reduce or terminate business to penalize non-conforming suppliers (Locke, 2013c). Yet in practice, only about half of firms report imposing penalties on their suppliers for social or environmental violations, with some academics arguing the number is actually much lower (Locke et al., 2009; Porteous et al., 2015). A lack of penalty may undermine the mechanism by which we expect a private standard to work.

Relationship with Supplier: Finally, the relationship between buyer and supplier may also influence the effectiveness of private standards (Barrientos and Smith, 2007; Hughes, 2005; Waldman and Kerr, 2014). Agri-food chains are often characterized by consolidated retailers and manufacturers, making suppliers dependent on the lead firm for business (Gómez et al., 2011). Mayer and Gereffi (2010) argue that this asymmetrical power dynamic allows lead firms to mandate compliance of their suppliers. However, the relationship between supplier and buyer is often more complicated and there is increasing evidence that buyers have less power over their suppliers than previously thought (Swinnen and Vandeplas, 2010; Tampe, 2016).

Instead, some scholars argue that taking a more collaborative approach to the compliance process might be more effective in driving change (Coslovsky and Locke, 2013; Frenkel and Scott, 2002; Hughes, 2005). Using a study of Nike's supply chain, Distelhorst et al. (2016) found that investment in the capacity of factory managers significantly reduced the number of egregious labor violations. Similarly, Hugill et al. (2016) found that suppliers improved more after visits from highly trained auditors, suggesting that capacity building through audit visits might be a pathway to improve practices.

In summary, the mechanisms by which company-led standards might affect change in supplier behavior remain contested. Some argue that, by the nature of companies' motives, company-led standards will either be largely ineffective or focus primarily on legal issues. Audits appear to be able to change some technical practices, but are less effective in encouraging more fundamental management shifts. Clear penalties should improve supplier motivation to comply, but whether penalties are regularly enforced remains unclear. Finally, the structure of the relationship between supplier and buyer appears to mediate the effectiveness of standards. We empirically test whether we see company-led standards create change, the difference between legal, technical and fundamental practices and the role of the relationship between buyer and supplier in this paper. We provide qualitative evidence for the role of capacity building and enforcement mechanisms on the program's effectiveness.

4. Data and empirical strategy

Evaluating the effectiveness of certification or other sustainability programs can pose challenges to causal inference when the selection into the program is not taken into account (Angrist and Pischke, 2009; Blackman and Rivera, 2011). Two selection effects are likely occurring within the FFF program. First, farms are chosen as a Woolworths supplier and second, they are selected into the FFF program as the program expanded over time.

To deal with these selection biases, we triangulate our empirical analysis using three approaches. First, we collected an unbalanced panel dataset from third-party FFF audits. The panel data allows us to

[2] Primary growers are growers with which Woolworths has a formal contract. Secondary growers supply indirectly to Woolworths and do not have a contract with Woolworths. Woolworths staff communicate with both primary and secondary growers on a regular basis.

evaluate the within-unit change in farm practices over time, controlling for farm-level and time effects. By using a panel dataset, we significantly limit the potential selection bias in our results. Unlike cross-sectional analyses, panel analysis avoids the likely correlation between selecting into the program and unobserved time-invariant farm characteristics such as manager capacity or progressiveness towards environmental issues. For selection bias to influence our panel analysis, the selection into the FFF program would need to be associated with within-farm changes over time that also affect the uptake of best management practices. Based on conversations with Woolworths staff and FFF participants, involvement in the FFF program did not change business relationships or provide other benefits for FFF participants that might influence environmental practices. The panel analysis also allows us to control for common time trends or annual shocks from unobserved factors that might affect uptake of environmental practices among all farms, such as changing government regulations, input price fluctuations or weather-related shocks.

Second, we conduct a cross-sectional survey of Woolworths growers and a randomly sampled control group of GlobalGAP certified farms. GlobalGAP is a private industry standard developed by major food retailers to improve agriculture and food safety practices. GlobalGAP certification represents a primary requirement to be considered a Woolworths supplier. The GlobalGAP program covers similar environmental topics to the FFF program, however GlobalGAP auditors, under the International Organization for Standardization (ISO) regulations, are not allowed to give advice during audit visits. The cross-sectional survey allows us to compare how FFF participants' practices differ from similar non-Woolworths growers, controlling for key variables that influence selection of becoming a Woolworths grower and selection into the FFF program. This analysis allows us to better explore the difference between the FFF and a similar industry program. Finally, we conducted in-depth interviews with stakeholders to corroborate our quantitative findings and explore mechanisms for driving change.

4.1. Panel data

We constructed an unbalanced panel dataset of 228 fruit, vegetable and flower farms from 953 audits conducted as a part of the FFF program from 2009 to 2016 (Table 1). On average, farms in our panel analysis have been involved in the FFF program for 3.2 years. The same third party auditing firm conducted all farm audits. Auditors use on-farm observations, verification of documents, soil samples and interviews with farm management to assess environmental practices of each farm. Farms that obtain a high audit score may receive up to two years of desktop audits where documentation is reviewed but no farm visit is conducted.

Table 1
Summary of panel data. New farms refers to farms receiving their baseline FFF audit.

Total audits	953
Full farm audits	834
Farms	228
Fruit	72
Vegetable	126
Flower	30
Average farm size (ha)	656
Proportion with direct contract	0.58
Average FFF tenure (Yrs)	3.18
New farms per year	
2008	42
2009	45
2010	35
2011	25
2012	27
2013	18
2014	23
2015	13

When farms receive a desktop audit, we impute practices based on results of the previous full-farm audit. This led to the imputation of 119 audit results (12.5% of all audits). If no audit is conducted for a farm in a given year, no imputation of data is conducted. Imputing data for desktop audits is preferred to assuming data is missing at random. Models run with non-imputed data do not significantly change our results (see SI).

We estimate the effect of the FFF program using a farm and year fixed effects panel regression model as given by:

$$Y_{it} = \theta_i + \delta_t + \beta \mathrm{FFF}_{it} + \epsilon_{it}$$

Y_{it} refers to the outcome (adoption of environmental-related best management practices), θ_i is the farm fixed effect, δ_t is the year fixed effect, FFF_{it} indicates whether the farm is involved in the FFF program in a given year and ϵ_{it} is the error term. We are interested in the estimation for the FFF impact (β). The farm and year fixed effects control for both unobserved time-invariant farm level variables that might affect the uptake of practices as well as time-varying shocks that may affect all farms in a given year. Time fixed effects also account for common linear time trends. We estimate adoption of environmental practices using ordinary least squares (OLS) as opposed to probit or logit models because the maximum likelihood estimator is inconsistent when used with fixed effects (Greene, 2004). We cluster standard errors at the farm level to account for serial correlation.

4.2. Cross-sectional survey

We also conducted a cross-sectional survey of Woolworths and non-Woolworths growers on the uptake of environmental best management practices. We administered an online survey to all Woolworths growers enrolled in the FFF program in the 2015–2016 growing season with a survey response rate of 70% (n = 117). On-farm observations were used to verify over two-thirds of survey responses. On average, Woolworths farmers in our survey analysis have been involved in the FFF program for 4.1 years.

For control data, we used the GlobalGAP South Africa database to construct a random sample of fruit and vegetable growers in South Africa. Flower growers were not well represented in the database so we used a random selection of flower growers listed on the three major flower trade associations' websites. Surveys and on-farm observations were conducted in-person and respondents were provided a 200 rand (~USD 15) gift certificate for participation. Our response rate among our control participants was 60% (n = 43).

We use a set of control variables to address potential selection bias (Table 2). Based on conversations with Woolworths staff, key selection criteria for becoming a Woolworths grower are being GlobalGAP certified and being more 'progressive'. In addition to using control farms that are GlobalGAP certified, we also use the number of international agricultural trips by the farm management team as a proxy for the progressiveness of a farm. Woolworths selected FFF participants by the contractual relationship they have with the grower, type of crop and location. We control for each of these factors in our model. We also control for other variables that have been demonstrated in the literature to influence uptake of environmental best management practices among farmers, including farm size, education level of farm manager and land tenure (Baumgart-Getz et al., 2012; Knowler and Bradshaw, 2007). We also control for the number of environmental audits (excluding FFF) conducted on the farm. Seventeen of our 21 control variables are balanced across treatment and control groups. As compared to the Woolworths growers, the control group tends to have slightly lower revenues, take fewer international trips and be less well represented in the Northern region.

We run an OLS regression in a matched dataset of treatment and control units that we construct using genetic one-to-one matching with replacement (Diamond and Sekhon, 2012; Mebane and Sekhon, 2011).

Table 2
Survey control variables used for regression analysis (prior to matching). Treatment refers to farms involved in the FFF program for 1 or more years; control farmers are non-Woolworths GlobalGAP certified farms. Farmers new to FFF ($n = 9$) are omitted. *P*-values refer to difference in means between treatment and control groups, $^*p < 0.05$.

Variable	Description	Treatment mean	Control mean	*P*-value	
Primary grower	Whether farmer has a direct contract with Woolworths	0.64	0.00	0.00	*
Age	Age of farm manager	45.58	47.42	0.35	
Experience	Years farming experience of farm manager	19.83	21.86	0.32	
Education	Scale of educational attainment of farm manager from no high school degree (1) to graduate degree (6)	3.47	3.33	0.50	
Ag Primary Inc	Agriculture is primary income source (0/1)	0.96	0.93	0.45	
Own	Own (vs. lease) land (0/1)	0.90	0.93	0.51	
Ln Distance	Log kilometers to nearest market to sell agricultural products	4.93	4.45	0.05	
Fruit	Grow fruit crops (0/1)	0.43	0.58	0.09	
Veg	Grow vegetable crops (0/1)	0.56	0.47	0.32	
Flower	Grow flowers (0/1)	0.18	0.09	0.16	
Region: W	Western Cape Province	0.33	0.49	0.09	
Region: E	Eastern Cape and Kwazulu Natal Provinces	0.11	0.16	0.43	
Region: C	Northern Cape, Free State, North West Provinces	0.11	0.09	0.74	
Region: N	Gauteng, Mpumalanga, Limpopo Provinces	0.44	0.26	0.03	*
Labor constraint	Whether the farm manager feels that access to full time labor constrains ability to operate farm (0/1)	0.21	0.09	0.05	
Loan rejected	Whether in last year the farm had been rejected for a loan. Proxy for capital constraint (0/1)	0.05	0.05	1.00	
Revenue: 6M–12M	Revenue bracket: 6–12M South African Rand (baseline 0–6M)	0.19	0.26	0.43	
Revenue: 12 + M	Revenue bracket: 12M+ South African Rand (baseline 0–6M)	0.61	0.40	0.02	*
Ln Ag Ha	Log of agricultural hectares under production	4.15	4.39	0.46	
Total int trip	Total international trips taken in last 5 yrs for agricultural purposes. Proxy for progressiveness of farm	4.22	1.35	0.00	*
Total audit	Total environmental audits conducted in last 3 years (excludes FFF, 0–5)	1.49	1.49	0.99	
Number obs.		*108*	*43*		

We match on the following key control variables: crop type, farm revenues, size of farm (logged hectares), number of international trips taken for agricultural purposes, number of environmental farm audits, age of farm manager, and distance to primary agricultural market (logged kilometers). Ten control observations were dropped from the analysis as a result of the matching process. We use standard error estimates that are robust to arbitrary heteroskedasticity. We also run the same model using other matching techniques, a logit model and with the unmatched dataset with similar results (see SI).

4.3. Outcome variables

Outcome variables were developed based on previous studies of sustainable agriculture practices, the feasibility of measurement, the relevance to South African agricultural challenges and whether the topic was consistently measured across audit years (Rasmussen et al., 2017). Some outcomes are only available in one of the two datasets. Farms for which the outcome did not apply were dropped during analysis (e.g., cover cropping for hydroponic growers). On-farm observations or document review was possible for the majority of outcomes, reducing the likelihood of self-reporting biases. The outcome variables used, their definitions and descriptive statistics are presented in Table 3.

We divide our outcomes into four groups based on groupings derived from the literature. *Legal practices* refer to those outcomes that are required by South African law. Proper disposal of chemical containers, a prohibition on burning waste and having a formal invasive species management plan are all legal requirements in South Africa. *Technical practices* refer to data measurement or other non-farm practices. *Fundamental practices* are those that relate to significant change toward more conservation-oriented farm practices that have been empirically shown to improve environmental outcomes (Clausen et al., 1996; Cuyno et al., 2001; Prasuhn, 2012; Wyland et al., 1996). Finally, *non-priority practices* are those practices that the FFF program did not directly promote and can act as a check to ensure we are not picking up impact where we expect none to exist. We also calculate group summary scales by taking the equal weighted average of all practices within each group. Averaging across multiple items is useful to reduce random measurement error (Ansolabehere et al., 2008).

4.4. Interviews with key actors

We conducted over 90 semi-structured interviews to better understand how the FFF program worked and how it compared to the GlobalGAP program. This included over 30 interviews with Woolworths farmers, 20 interviews with Woolworths staff and auditors and over 40 interviews with control farmers. We purposefully sampled Woolworths farmers to represent the full range of growers' experiences across length of time in the FFF program, contractual relationship, overall FFF performance, geography and crop type. All control farmers involved in the study were interviewed. Interviews lasted between thirty and ninety minutes. We used NVivo, a qualitative coding software, to analyze interview notes for key trends based on categories discussed in Section 3.

5. Results

In general, the FFF program is associated with increased adoption of environmental best management practices, both in the panel analysis and in the matched comparison to non-Woolworths farms. In examining the summary outcome scales from the panel analysis (Fig. 1), we see that FFF involvement is associated with a statistically significant increase in all outcome types prioritized by the FFF program. The effect of the FFF program is most pronounced for the legal scale, with involvement in the FFF program being associated with a 14-percentage point, or about one half of one standard deviation, increase in uptake of legal practices (significant at the 1% level). The FFF program is also associated with a 9-percentage point increase in the technical scale (significant at the 1% level). We see a small, but statistically significant improvement of three-percentage points in the fundamental outcome scale (significant at the 5% level). We see no effect of the FFF program on non-priority outcomes. According to survey results, Woolworths and control farmers have similar legal practice uptake, but FFF is associated with large and statistically significant improvements in technical and fundamental scales (see SI).

Turning to individual farm management practices, we find from the panel analysis that being involved in the FFF program is associated with an increased likelihood of disposing of chemical containers and waste in a more responsible way, having a formal invasive species management plan, recycling, and monitoring soil moisture (Fig. 2). These results are statistically significant at the 1% level. The FFF program is also associated with using more integrated pest management (IPM) practices

Table 3
Outcome variables, their definitions, means and standard deviations (in parenthesis) across datasets, split by treatment. Panel statistics are for baseline and end-line audits. Survey statistics are based on un-matched data. 0/1 denotes binary variables.

Group	Variable	Description	Panel: Begin	Panel: End	Survey: ctrl	Survey: treat
Legal	Chem Cont	Dispose of chemical container through approved recycler (0/1)	0.64 (0.48)	0.86 (0.35)	0.91 (0.29)	0.97 (0.17)
	Don't burn waste	Do not incinerate waste on farm (0/1)	0.57 (0.50)	0.73 (0.45)	0.74 (0.44)	0.84 (0.37)
	Invasive Mgmt.	Formally manage invasive species (0/1)	0.47 (0.50)	0.63 (0.48)	–	–
	Clear invasives	Cleared invasive species in last year (0/1)	–	–	0.87 (0.34)	0.99 (0.12)
Technical	E Policy	Have a written energy reduction policy (0/1)	0.20 (0.40)	0.56 (0.50)	0.26 (0.44)	0.74 (0.44)
	Recycle	Recycles non-hazardous plastic (0/1)	0.50 (0.50)	0.66 (0.47)	0.40 (0.50)	0.79 (0.41)
	WUE	measure water applied per kg crop produced (0/1)	0.49 (0.50)	0.66 (0.47)	0.02 (0.15)	0.78 (0.42)
	Measure moist	Measure soil moisture (either by hand or soil probe) (0/1)	0.42 (0.49)	0.71 (0.46)	–	–
	Enviro Capex	Whether invested in four sustainability- related capital investments on the farm in the last 5 years. Scaled to 0–1	–	–	0.40 (0.25)	0.54 (0.28)
Fundamental	IPM Practices	Number of integrated pest management (IPM) practices used (out of 9 for survey, 5 for audit). Scaled to 0–1	0.50 (0.25)	0.57 (0.24)	0.59 (0.18)	0.73 (0.17)
	Crop rotation	Use crop rotation (only applies to annual crops) (0/1)	0.80 (0.40)	0.87 (0.34)	0.75 (0.44)	0.83 (0.38)
	Cover crop	Use cover crop. For annual crops this refers to cover used between cropping seasons, for perennial crops this refers to cropping between crop rows (0/1)	0.46 (0.50)	0.53 (0.50)	0.22 (0.42)	0.52 (0.50)
	SOC percent	Soil organic carbon percent in soil (0–1)	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)
	Conserv Till	Use conservation or no-tillage practices (0/1)	–	–	0.60 (0.50)	0.77 (0.42)
Non-priority	Use compost	Use compost (0/1)	0.44 (0.50)	0.40 (0.49)	0.48 (0.51)	0.52 (0.50)
	No herbicides	Do not use herbicides (0/1)	0.44 (0.50)	0.36 (0.48)	–	–
	Drip irrigation	Use drip irrigation (0/1)	0.52 (0.50)	0.48 (0.50)	–	–
	Number obs.		*228*	*185*	*43*	*108*

(significant at the 5% level). We see some evidence that the FFF program is also associated with increasing the likelihood of measuring water use efficiency and using a cover crop, however these results are less stable across model specifications (significant at the 10% level).

Putting these changes into context, our panel results suggest that being involved in the FFF program for one or more years is associated with farmers being 15 percentage points more likely to recycle their waste and dispose of their chemical containers in a responsible way. They are also about 15 percentage points more likely to stop burning their waste, have a formal alien species management plan in place and measure the moisture of their soil. Similarly, the FFF program is associated with a four-percentage point increase in the use of integrated pest management practices i.e., the FFF program encouraged one in five farms to use one additional integrated pest management practice.

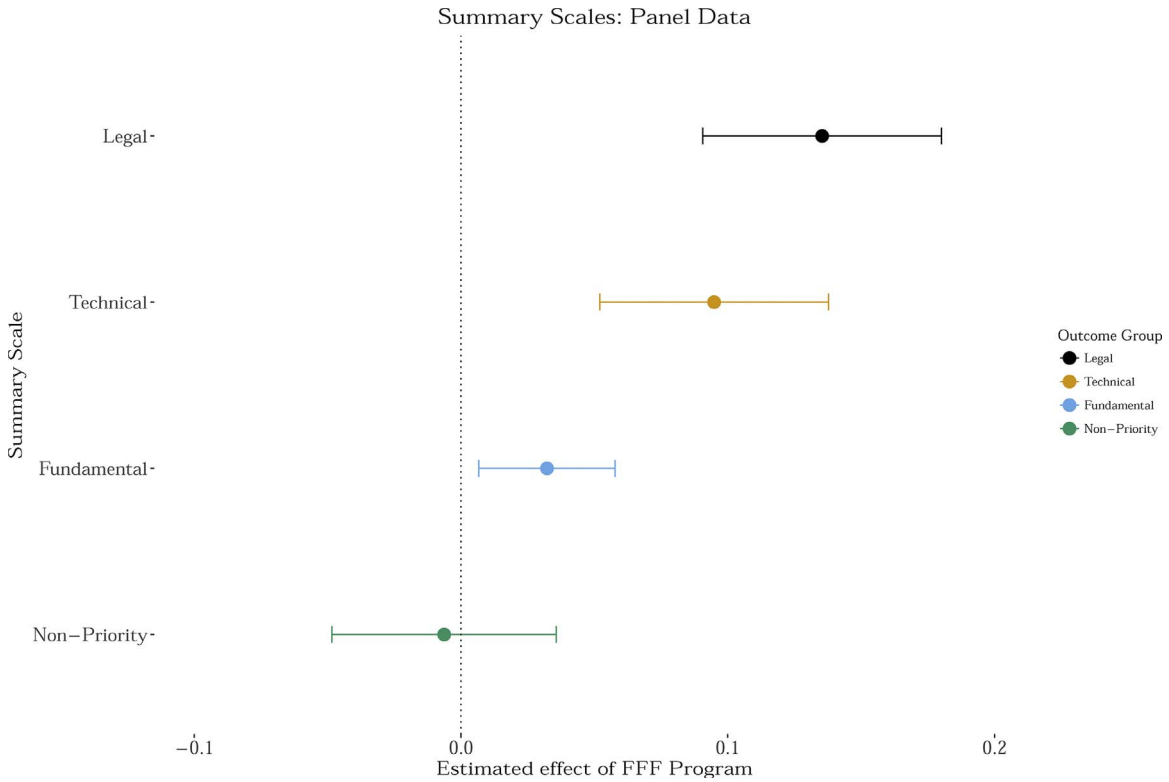

Fig. 1. Plot of summary outcome scale coefficients from panel data, using farm and year fixed effects. Summary scales were constructed by taking the equal weighted average of all outcomes within each group. Error bars represent 95% confidence intervals. Colors represent the outcome groups suggested by the literature. See SI for regression table and survey summary scale results.

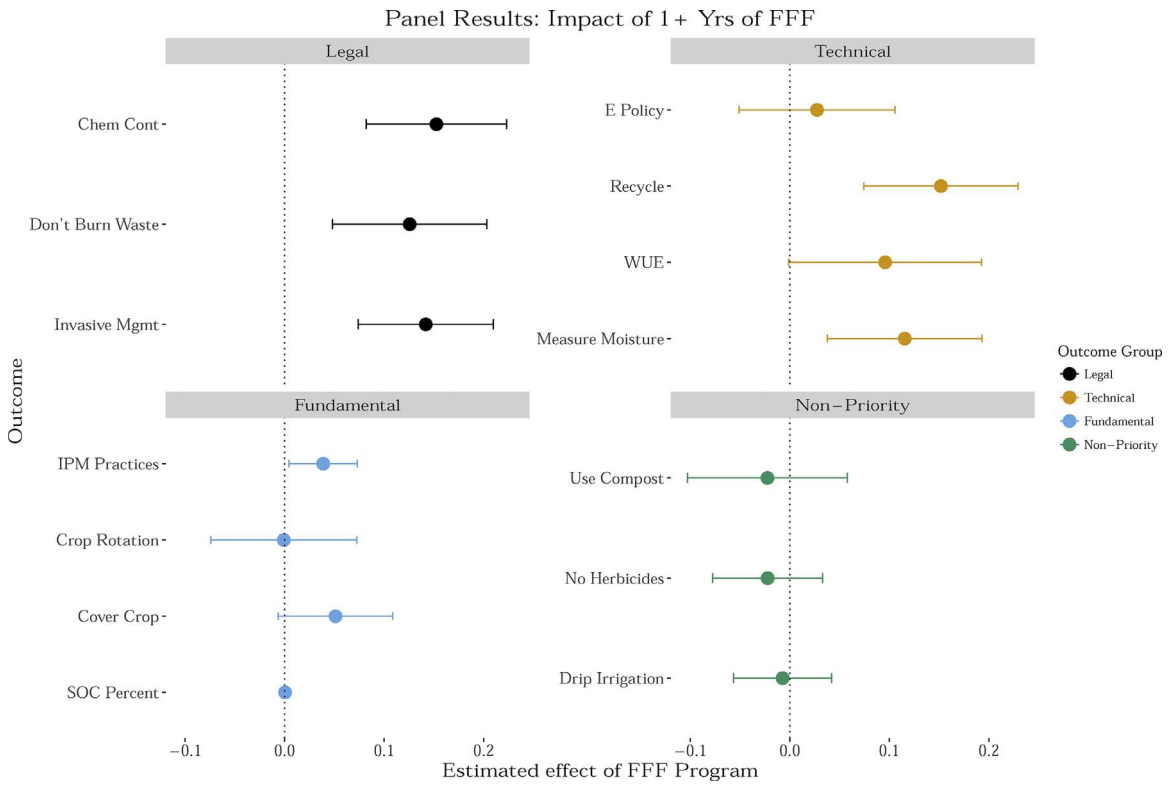

Fig. 2. Plot of outcome coefficients for FFF involvement from panel analysis using farm and year fixed effects. Error bars represent 95% confidence intervals. Colors represent the outcome groups suggested by the literature. See SI for regression table.

The panel results suggest that the FFF has no discernible impact on soil organic carbon percent. Soil organic carbon often takes five to ten years to build up based on improved management practices, so this result is unsurprising given the average duration of the FFF program among panel farms is 3.2 years. FFF is also not associated with increased uptake of crop rotation. Crop rotation at the start of the FFF program was very high (80% uptake). The FFF program does not appear to have an effect on practices that are not universally recommended by the program, such as the use of compost, drip irrigation or stopping herbicide use.

To further explore these results, we subset our data in ways suggested to influence FFF effectiveness. We find limited evidence that the contractual relationship with Woolworths (primary versus secondary) influences uptake of best management practices. In examining uptake among fruit and vegetable producers, we find vegetable farmers are more likely to measure soil moisture and use cover cropping, whereas fruit farmers are more likely to measure water use efficiency.

The survey results are largely consistent with the panel analysis described above except among legal practices, where control and FFF farmers are more similar. From the survey analysis, farms in the FFF program are more likely to clear invasive species, have an energy policy in place, calculate water use efficiency, use integrated pest management practices and use cover crops as compared to control farmers (significant at the 5% level) (Fig. 3). For example, the FFF program is associated with an 18-percentage point increase in likelihood to clear invasive species as compared to similar non-Woolworths farms. On average, farmers involved in the FFF program for one or more years use eleven percentage points more IPM practices than control farmers. This translates into the use of roughly one more practice (out of nine) among treated farmers. The FFF program is also weakly associated with increased likelihood to invest in environmentally-related capital improvements, use crop rotation and use conservation tillage, however these results are more sensitive to model specification (significant at the 10% level).

The survey and panel results diverge on a few variables. We see strong improvements in chemical container and waste management in the panel analysis. We see more limited differences between GlobalGAP and FFF farmers on these outcomes in the survey analysis. The survey analysis also suggests FFF farmers are much more likely to have an energy policy in place. In general, we see more pronounced effects in the cross-sectional results. These differences are likely in part driven by the different control groups being used in each study type. In addition, matching may not account for all the unobserved differences between FFF and control farmers, potentially upwardly biasing our survey results.

5.1. Robustness checks

We also conducted the panel analysis using non-imputed data and modeling a linear time trend. The results are largely consistent across data type and model runs (see SI). For the survey analysis, we ran models on the unmatched dataset, with alternative matching techniques and using a logit model with similar results to those presented. We also used a continuous treatment indicator. Results were largely stable regardless of treatment variable categorization. By binning all farms exposed to the program together we are likely underestimating the full effect of the program, as FFF impact appears to increase over time.

5.2. Qualitative results

Advice given during the FFF audit visit was the single most distinguishing factor of the FFF program. Two-thirds of FFF participants interviewed found advice provided by the FFF auditors useful for their farm management. In contrast, only 5% of control farmers mentioned receiving advice from GlobalGAP or other environmental farm audits. This difference may help to explain the uptake of practices because, as one control farmer explained, “GlobalGAP doesn’t provide feedback, making it difficult to improve problem areas.” The agricultural

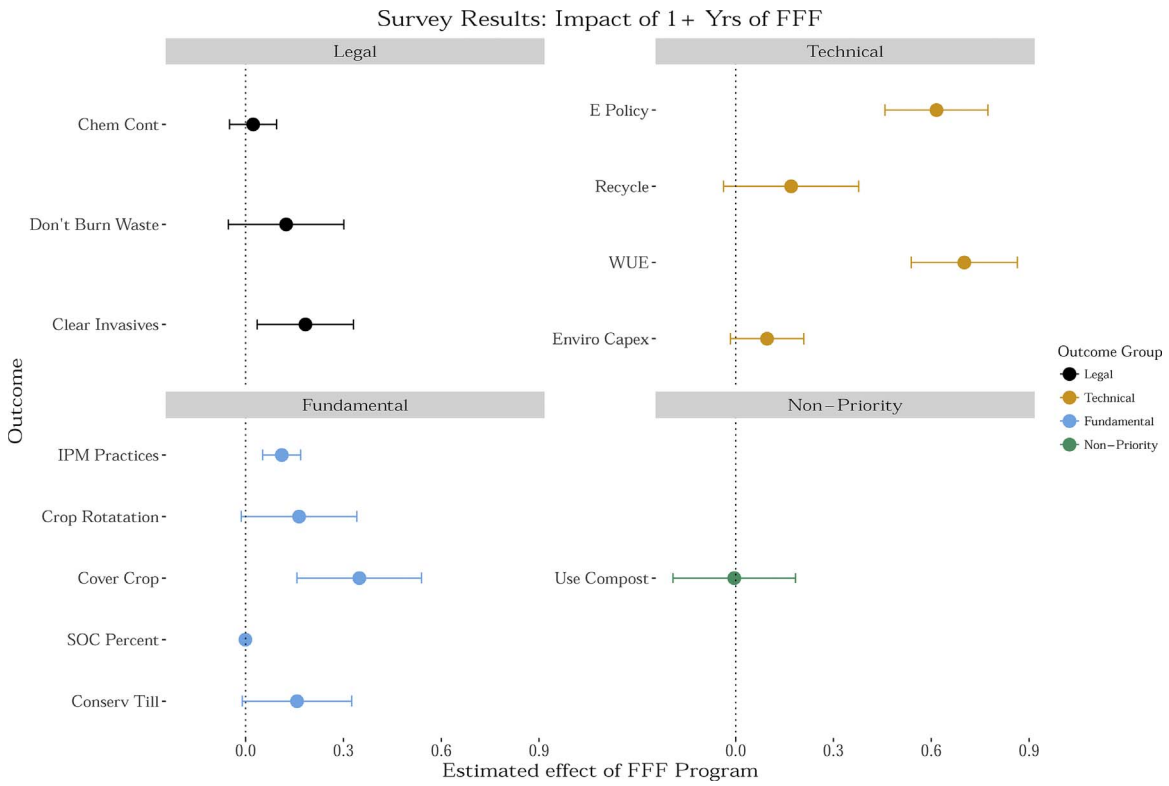

Fig. 3. Plot of outcome coefficients for FFF involvement from matched cross-sectional analysis. Error bars represent 95% confidence intervals. Colors represent the outcome groups suggested by the literature. See SI for regression table.

competence of the FFF audit staff was also frequently cited as a key differentiator of the FFF program. As one farmer put it, "When the GlobalGAP auditor drives in and passes a stand of alien [invasive] trees, they tell you 'nice trees'. When a Farming for the Future auditor drives up, they ask how you are addressing the alien species on your farm and work with you to create an appropriate management plan."

Two primary pathways emerged from interviews through which FFF influenced farm decisions. The requirement-based pathway refers to a small subset of farms interviewed that see the FFF program as a requirement to do business with Woolworths. They use words like 'required' and 'forced' to describe the changes they have made on their farms as a result of the FFF program. These farmers report changing their practices just enough to receive a sufficient audit score, typically right before the upcoming audit visit. However, some farmers did not believe that Woolworths would follow through with terminating their contract for failing to comply with the FFF program. For example, one farmer commented "They [Woolworths] will always get plums on their shelves, even if they have to source it from a farm that has never heard of Farming for the Future." This requirement-based view of environmental audits was universal among control-group farms.

In contrast, two-thirds of Woolworths farmers interviewed held a more partnership-based view of the FFF program. Farmers talked about FFF as a 'philosophy', 'opportunity to learn', or a 'collaborative effort' with Woolworths. Rarely did farmers feel that they were being forced to change their practices. Instead, as one farmer explained, "I feel like if I can't do a practice, I'll just explain why it doesn't work for me, and they [the auditors] totally understand." Many of these farmers also reported a positive, long-term business relationship with Woolworths. As one grower put it, "Most retailers care that you deliver beans. Woolworths cares how you grow your beans, what your yields for your beans were and so on… It's much more of a collaboration."

Both control and treatment farms also mention that one benefit of the environmental audits is providing the necessary activation energy to "do things we know we need to do." Farmers report that both audits helped raise awareness, particularly of legal requirements. Many farmers mentioned that prior to involvement in either GlobalGAP or FFF they were unaware of many legal requirements, as no farmer reported a government visit to check the environmental compliance of their farm. According to Woolworths' farmers, FFF did a better job of highlighting South African-specific legislation, particularly around invasive species management.

6. Discussion

Some scholars have questioned whether standards set by companies are able to drive change. This study provides evidence that a company-led approach that goes beyond a traditional audit can be effective in driving the adoption of environmental best management practices at the farm level. The improvements observed, including improved water management, invasive species control and soil protection, are highly relevant to the environmental pressures facing South Africa today (Goldblatt, 2011). Our results highlight the opportunity company-led standards can have on supplier practices, if implemented effectively.

In grouping outcomes as suggested by the literature, the panel analysis shows significant effects of the FFF program on all *legal practices*. These results support the hypothesis that company-led standards are in place to protect companies' interest. Woolworths would be negatively affected, either through reputational damage or a disruption in supply, if their farms were found to be non-compliant with South African laws. In comparing panel and survey results, we see that FFF farmers are not substantively more likely to address legal outcomes than GlobalGAP farmers, with both groups having very high levels of uptake. This is unsurprising, as GlobalGAP represents a retailer-led standard to ensure environmental compliance and their members have similar motivations to Woolworths to protect their reputation and supply.

Second, as predicted by analyses in other sectors (Barrientos and Smith, 2007; Locke et al., 2009), we see improvement among FFF

participants on *technical practices* such as having an energy policy in place or monitoring water use. In comparison to GlobalGAP, farmers appreciate the support the FFF auditors provide in implementing these new practices.

We also measured small improvements in three of the five *fundamental practices* captured in our study. These results were more pronounced for farms involved in the program for a longer period of time. Adopting integrated pest management practices, incorporating cover crops, and adopting conservation tillage are significant management shifts for conventional farmers and have been tied to improved environmental outcomes at the landscape level (Clausen et al., 1996; Cuyno et al., 2001; Prasuhn, 2012; Wyland et al., 1996). The agriculture extension literature suggests that, in general, shifting farm management practices to more conservation-oriented approaches is very challenging (Knowler and Bradshaw, 2007). Similarly, the audit literature has shown that audits are not an effective tool for changing more fundamental management practices (Barrientos and Smith, 2007; Distelhorst et al., 2015).

The ability to influence fundamental management practices is likely in part because the FFF program moves beyond the traditional 'check the box' audit exercise to a more relational approach. Advice by trained audit staff was a significant differentiator of the FFF program as compared to other environmental audits farms received. This is consistent with calls for more capacity building among suppliers to drive change (Hoang and Jones, 2012; Locke, 2013b).

Surprisingly, having a direct contract with Woolworths does not appear to be sufficient to drive the adoption of best management practices. We expected that the contractual relationship between the lead firm and primary growers would lead to a higher responsiveness of primary growers to the FFF program (Gereffi et al., 2005). However, primary growers in the FFF program did not have higher adoption of best management practices as compared to secondary growers. Woolworths has direct relationships with most of their secondary suppliers, despite no formal contract. Many secondary suppliers also report a positive and long-term relationship with Woolworths. This suggests that, although the contractual relationship may not influence effectiveness, a long-term commitment to suppliers may be an important component of FFF's effectiveness.

The ability of the FFF program to change practices might also relate to the environmental focus of the standard. Many scholars argue that improving suppliers' environmental practices as opposed to labor practices may be more amenable to a company intervention as these practices are often associated with cost savings for the supplier (LeBaron and Lister, 2015; Mayer and Gereffi, 2010). Cost savings did not come up as a major driver for adopting the practices observed in this study, but a detailed cost-benefit analysis was not undertaken.

Relevance of the practices encouraged by the standard also appears important in influencing uptake. For example, we found a larger and statistically significant uptake of measuring soil moisture among vegetable farmers and a lower uptake of water use efficiency (WUE) calculations as compared to fruit growers. According to farmers, measuring soil moisture was seen as a very useful tool for vegetable crops, whereas calculating WUE was less helpful due to the crops' shorter rotation. This is corroborated by interviews with farmers noting that the FFF program asked about practices that were much more relevant to their farm than GlobalGAP audits. These findings suggest that making practices relevant to a given farm group is important in encouraging change. This is particularly important in the company-led standard space where many companies apply one agriculture standard across diverse crops and geographies. For example, the food sector's commonly used Sustainable Agriculture Initiative standards have similar environmental requirements across many crop types (Sustainable Agriculture Initiative, 2015). Based on our findings, these general requirements will be less effective in changing farmer behavior.

We also found that farmers who saw the FFF program as a partnership with Woolworths were more open to changing their practices based on FFF visits. In contrast, when farmers felt that they were required to comply with the FFF program they were less receptive to the feedback of the FFF auditors. The feeling that Woolworths' commercial staff is bought into the farm's long-term viability appeared to be an important component of the partnership-based view of FFF. Yet as Woolworths has expanded, farmers report a shift towards a more requirement-based view of the program, suggesting some challenges with scaling up this partnership-based approach.

In contrast, the requirement-based model for encouraging change seems only marginally effective, in large part because farmers did not believe Woolworths would terminate their contract as a result of an environmental violation. The lack of clear penalties for failing to comply with a social or environmental program has been suggested to reduce their effectiveness (Porteous et al., 2015). The fact that we are able to see changes in practices despite the perception of weak penalties suggests that the threat of contract termination may not be the primary driver of change. That being said, almost all stakeholders agree that FFF's impact could be further amplified if better incentive structures for compliance were in place. These incentives might include price premiums, preferred supplier programs where farms meeting sustainability criteria get higher or more stable orders, additional training opportunities or as simple as recognition through annual supplier awards.

7. Conclusion

We find that involvement in Woolworths' company-led standard program is associated with a statistically significant improvement of most environmental management practices targeted by the intervention. The FFF program was associated with significant positive improvements in both legal and technical practices, confirming that a standards-based approach is likely most effective at dealing with practices that are easily verifiable through site visits. However, we also saw small improvements in fundamental farm management practices, suggesting the FFF program is more effective than traditional audit-only approaches. The primary driver of FFF's success appears to be its more partnership-based approach where highly trained auditors provided farm-specific recommendations. The direct relationship between Woolworths and their growers likely facilitated this interaction, suggesting a long-term investment in suppliers is an important pre-requisite for driving change.

As outlined in the introduction, we identified the Woolworths program as a critical case, suggesting that because we see positive impacts of this company-led standard, we cannot infer that all company-led standards would have such an effect. Instead, these findings highlight the potential for company-led initiatives to encourage more sustainable agricultural practices if coupled with capacity building and a long-term relationship with suppliers.

The positive effect of the FFF program should not discount the role of a strict audit-based approach, particularly in countries with limited government enforcement. The GlobalGAP program appears to be effective in improving compliance with legal requirements that are rarely enforced by the government. Yet as companies are increasingly committing to go above and beyond public regulations and industry standards, there is a clear value-added to focusing more on a capacity building and partnership-based approach to driving change. This recommendation is in contrast to many food retailers' current strategies to require multiple environmental audits of their suppliers. Based on our findings, additional audits will not help transition farms to more sustainable cultivation strategies. Companies should explore using their resources to provide targeted support to their growers in a more collaborative approach to driving change.

While this study makes an important contribution to increasing the evidence of the role of private environmental governance in agri-food supply chains, we remain limited to examining the adoption of best management practices. Although many of these practices have been suggested in the literature to relate closely to improved environmental

outcomes, future research should explore direct measurement of environmental outcomes. This study is also constrained to environmental issues. Future studies might explore the potential tradeoffs and synergies between social and environmental impacts of company-led initiatives.

This study represents an original, rigorous analysis of a company environmental standard influencing farm-level management practices. These results have significant implications for the rising trend in private environmental governance globally. Our results suggest that, if implemented correctly, company-led sustainable supply chain initiatives can help to improve environmental management practices at the farm level.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.gloenvcha.2017.10.006.

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