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ORIGINAL ARTICLE

Do grassroots interventions relax behavioural constraints and improve adoption of nutrition-sensitive food production systems?

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Abstract

In most developing countries, agricultural policies and programs are designed to promote productivity growth with modern inputs and technologies, and the success of these policies is measured primarily along the dimensions of technology adoption, with limited reference to the ancillary impacts on behavioural outcomes that may be a prerequisite to adoption. We test whether grassroots programs can additionally relax behavioural constraints, potentially enhancing the adoption of diversified production systems. In Odisha, India, using a series of laboratory-in-field experiments and survey instruments to elicit farmers' preferences for risk, agency and aspirations for themselves and their children, we find that respondents in villages where grassroots interventions were promoted showed significantly lower levels of risk aversion and higher aspirations for themselves and their children, along with improvements in production and consumption diversity. However, we do not find a mediating role of reduced risk aversion in improving direct program outcomes. Our results show that grassroots approaches are effective in inducing a shift towards changing production systems, and relaxing behavioural constraints, that can be leveraged over time to strengthen impacts.

KEYWORDS

aspirations, India, laboratory-in-field experiments, production diversity, prospect theory, risk preference

JEL CLASSIFICATION

D9, J16, Q1, Q5

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1 | INTRODUCTION

Conventional studies evaluating agricultural interventions tend to focus on tangible impacts such as yields, input expenditures or even the nutritional impacts arising due to increased incomes or home consumption of agricultural output (Ayenew et al., 2018; Pellegrini & Tasciotti, 2014). The logic for this focus is quite simple: these are frequently the primary outcomes the funding agencies sponsoring these interventions are pursuing, and such impacts can typically be easily observed and quantified. Interventions that promote livelihoods and collective action, however, can have important impacts that are manifested through improvements in behavioural outcomes that are not so easily observed, but may be an important first step in enhancing the adoption of new practices and achieving some of these other outcomes. However, interventions designed to encourage changes in the dominant agricultural production systems are often at odds with conventional practices in many rural communities, and such interventions may fail to gain traction as farmers prefer to simply maintain the status quo and eschew risky changes in behaviours or practices, even at the expense of enhanced livelihood and nutritional outcomes, leading to risk-induced low productivity and poverty traps (Brick & Visser, 2015). In other cases, farmers are confronted with thin input or output markets, restricting their ability to alter behaviours or practices (Kebede, 2022; Yesuf & Bluffstone, 2009). In still other cases, the desired change in behaviours or practices is conditional on strategic coordination among individuals and households that can be difficult to sustain or even secure in the first place. These constraints can pose serious challenges for civil society organisations and government agencies that aim to advance and measure changes in the development of resilient and sustainable local food systems within these communities.

In developing-country agriculture, one of the most important behavioural changes entails the adoption of new agricultural technologies or practices. This is especially the case for small-holder farmers (Llewellyn & Brown, 2020) for whom access to credit to experiment with new technology is inadequate, and agriculture insurance to hedge against risk is often missing. The myriad factors that have been identified as contributing to or inhibiting technology adoption include tenurial arrangements, farm size, education, credit constraints, social networks and social learning and risk (Foltz, 2003; Mottaleb, 2018; Palis, 2006; Wyckhuys & O'Neil, 2010). In nonirrigated or rain-fed agriculture, diversification arguably increases risks as returns and profits become more uncertain. For one, farmers need to procure new seeds, rather than recycling seeds from previous harvests as is common in this area for cereal crops. Similarly, with uncertain weather and rain conditions, profit margins would be highly uncertain. Furthermore, output markets for noncereals may be thin, which increases price volatility in the absence of support prices. Finally, geographically remote rural communities such as the ones in which this research is set have limited access to input, output and credit markets, making any deviation from traditional practices inherently risky.

Through this paper, we explore whether grassroots programs aimed at production system diversification in support of greater dietary diversity and nutrient sensitivity in local food systems are associated with changes in behavioural outcomes and whether adoption of consumption and production diversity is mediated by improved behavioural outcomes. We do this in the context of two large agriculture–nutrition projects—Pathways and TARINA—both implemented by CARE India, a nongovernmental organisation (NGO), with the aim of improving livelihoods and agricultural productivity in the Indian state of Odisha, with a particular focus on women. The interventions aimed not only to improve access to agricultural inputs, markets and technologies but also to change farmers' practices through targeted behaviour change communication (BCC) activities implemented largely through village, farmer and self-help groups. With these project objectives in mind, we focus on two questions. The first is the overarching question of whether CARE's activities are associated with more diversified local food systems. Specifically, we study whether villages that have previously benefitted from CARE's activities are more likely to diversify their production practices, particularly towards more

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nutrient-dense foods such as pulses and more likely to diversify their consumption practices. The second is the deeper question of whether CARE's activities are associated with changes in behaviours and preferences. To this end, we conducted a series of framed- and survey-based experiments to gain greater insight into farmers' decision-making processes and their ability to coordinate with members of their community to provide public benefits commensurate with CARE's goals. In short, we study the mechanisms that lead to behavioural change in local food systems by not only assessing the program's direct association with production and consumption diversification but also exploring its indirect relationship with reduced behavioural constraints, improved aspirations and increased empowerment. Finally, recognising risk aversion as a major constraint to the adoption of new practices, we test whether changes in production and consumption diversity are mediated by changes in risk preference.

Our paper contributes to two strands of literature. First, we contribute to the literature examining how grassroots agriculture interventions affect behavioural outcomes of farmers. Along with direct outcomes such as knowledge retention, adoption and yield, agriculture and development interventions may also affect nontangible outcomes such as risk aversion, cooperative behaviour, changes in aspirations and personal agency. In fact, there is now a wealth of literature that looks at the impact of agriculture, social protection and transfer programs on behavioural outcomes (Ambler & De Brauw, 2017; Quisumbing et al., 2019; Salazar & Fahsbender, 2018; Waqas & Awan, 2019). These outcomes tend to get ignored when measuring programmatic success, but are nonetheless important, especially when focussing on women within the household who, in their multiple roles in managing both on-farm production and consumption decisions, are important agents of change and thus central to the design of CARE's interventions. Without understanding the nature of these behavioural constraints, it is difficult to gain traction on the problem of low adoption or disadoption of practices. Studying the determinants of, or constraints to, changes in behaviours and practices can provide considerable insight into how programs, investments and policies—beyond conventional efforts to increase food grain production and caloric security—can effect change in this context.

We also contribute to the literature assessing how grassroots agriculture interventions can contribute to promoting consumption and production diversity. Diversified production can be beneficial for food security in several ways (Haddad, 2000). First, by diversifying production and increasing the production of higher value crops, farmers may ultimately have higher incomes from the sale of marketable surpluses (Koppmair et al., 2017), allowing them to consume diverse and potentially more expensive foods such as meats and fruits (Pellegrini & Tasciotti, 2014). Additionally, to the extent that these food items are also used for home consumption, farm households may increase the consumption of more nutritious food items (Ayenew et al., 2018). There is however mixed evidence on whether and how production and consumption diversity—and ultimately household nutrition—are linked, with some highlighting the positive relationship between the two (Dillon et al., 2015; Kumar et al., 2015), and others pointing to the mixed or conditional linkage between diversity in on-farm output and household food basket and nutrition (Shively & Sununtnasuk, 2015; Sibhatu & Qaim, 2018). There is strong evidence that production diversity is especially important where functioning markets are sparse, the communities are geographically remote, and most farmers consume what they grow, with very little marketable surplus (Hirvonen & Hoddinott, 2017; Lovo & Veronesi, 2019).

Beliefs related to both production and consumption practices are often difficult to change. While efforts to change those beliefs may take years, even decades, of engagement, education and conversation, far too little is known about the underlying and often unobservable constraints to change. The research presented in this paper is meant to inform the sorts of behavioural or institutional constraints that are perhaps most entrenched, or at least most likely to act as a binding constraint to systems-level transformations and the community level, and to test how grassroots agriculture-related interventions have relaxed these behavioural constraints, while improving production and consumption diversity.

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2 | INTERVENTION BACKGROUND

In late 2015, the Bill and Melinda Gates Foundation funded a consortium of researchers, development practitioners and NGOs to explore solutions to the problem of hunger and malnutrition in India through a 'food systems' lens (Pingali, 2015). This consortium, known as Technical Assistance and Research for Indian Nutrition and Agriculture (TARINA), operated in the states of Bihar, Odisha and Uttar Pradesh and aimed to redirect agricultural policy from an overt bias towards staple grains and towards a broader food system focus that considers the important linkages between agricultural production and household nutrition (TARINA, 2018). Importantly, TARINA focussed on agricultural pathways for enhancing the rural poor's year-round access to affordable, diverse and high-quality foods that are rich in micronutrients.[1]

In Odisha, CARE India's contribution to TARINA builds on prior work conducted under a project entitled Pathways to Empowerment (Pathways, for short), also supported by the Bill and Melinda Gates Foundation between 2012 and 2016. Pathways worked in two districts in Odisha to promote more productive and equitable participation, especially among scheduled caste (SC) and scheduled tribe (ST) farmers in sustainable agriculture.[2] To that end, Pathways worked with existing self-help groups to strengthen solidarity among SC and ST women farmers, promote sustainable and intensified agricultural practices to increase agricultural productivity and diversify livelihood strategies, enhance women's access to markets and services using a value chain approach and improve access to information, including information on farming techniques, markets, public and private sector services, nutrition and other development opportunities to diversify livelihoods (CARE, 2018).

Under TARINA, CARE's activities leverage many of the institutions and interventions that were introduced under Pathways. For example, by working through self-help groups that participated in Pathways activities, TARINA has sought to introduce and promote legume (specifically, pulse) rotations into the rice production system; engaged in nutrition education and nutrition awareness building; improved goat husbandry, feed management and value chain linkages; intensification systems for homestead/kitchen gardens; women's empowerment through gender-focussed interventions, awareness building and behaviour change; and storage technologies for reducing postharvest losses. Behavioural change communications (BCC) interventions delivered through village groups around production and consumption diversity and kitchen garden promotion were implemented almost universally in all intervention villages, while a subset of villages also received interventions around dairy, small ruminants and postharvest storage. CARE's interventions were demand-driven and voluntary, and apart from specifically targeting SC/ST households, CARE did not employ any income-based targeting of households.

3 | BEHAVIOURAL OUTCOMES: THEORY AND IMPLEMENTATION

In this section, we introduce the underlying theories that guide the behavioural experiments and modules we implemented in the field, along with the rationale behind their inclusion in this study. By and large, researchers working in the behavioural sciences and behavioural economics are

[1]The project's main objectives are to (a) provide technical assistance in redesigning agricultural projects to ensure nutrition outcomes at scale, (b) provide assistance and evidence for policy reform that enhances diet quality at affordable prices and (c) build capacity to design and implement nutrition-sensitive agricultural programs and policies.

[2]The SC and ST designations (frequently combined as SC/ST) are official designations recognised in the Indian constitution.

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familiar with the theories and experiments described below. However, in developing countries, the implementation of some of these experiments is relatively uncommon but gathering traction.

3.1 | Prospect theory

Traditionally, some researchers have preferred to estimate the effects of risk econometrically, often estimating a production function along the lines of those proposed by Just (1975). However, starting with Binswanger (1980), many researchers have sought to elicit these otherwise unobservable behavioural characteristics through carefully constructed field experiments. Many of these have assumed that preferences conform to expected utility theory (EUT). In their seminal paper, Kahneman and Tversky (1979) highlighted choice problems in which respondent preferences systematically deviated from what would otherwise be predicted if the respondents strictly adhered to the behavioural axioms of EUT, concluding that EUT is too restrictive to adequately describe decision-making under risk. Among the key features of Kahneman and Tversky's Prospect Theory (PT) are that individuals tend to prefer certainty over doubt (when comparing potential gains), dislike losses (and would risk large potential losses to avoid smaller, certain losses), evaluate changes based on reference levels rather than the end result and overweight the likelihood of low probability events and underweight the likelihood of high probability events (see also Tversky & Kahneman, 1992, which introduced a cumulative representation of uncertainty, appropriately dubbed Cumulative Prospect Theory, CPT). These systematic features of decision-making under uncertainty result in a value function that is generally concave for gains and convex for losses. As an alternative to EUT, CPT therefore allows for more flexibility in characterising responses to risky situations. CPT does not reject EUT outright, but rather is a general model of decision-making under uncertainty within which EUT is a specific case. Unlike EUT, where only an individual's risk aversion coefficient characterises decision-making under uncertainty, in CPT, three important parameters characterise individual behaviour. In this paper, we study the parameter (σ) that dictates the curvature of the prospect value function and can be thought of as a measure of risk aversion.[3]

3.2 | Empowerment and aspirations

One important avenue through which CARE has aimed to change practices is by encouraging improved household nutrition through increasing women's empowerment. A growing body of literature demonstrates how increasing women's empowerment can lead to various positive household outcomes, including more equitable distribution of household resources, more nutritious household food consumption (Malapit & Quisumbing, 2015) and better health and educational outcomes for children, especially girls (Glewwe, 1999; Thomas, 1994). In addition, women's empowerment can be directly associated with better agricultural outcomes and productivity gains (Diiro et al., 2018; Seymour, 2017) and the adoption of improved agricultural practices and technologies (Cornish, 2018). Empowering women is thus an important outcome in itself.

An important, and related, behavioural response that works both as a driver of, and a response to, increased livelihood opportunities, is an increase in aspirations. There has been considerable recent research on what determines the formation of an individual's hopes and beliefs about her future, and how this in turn affects investments towards realising her beliefs. For example,

[3]Details of the prospect theory experiment are available in the Appendix S1.

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recent research on aspirations and poverty examines the relationship between future-oriented behaviour and investment in improving social and economic well-being (Favara, 2017; Lybbert & Wydick, 2018; Wuepper & Lybbert, 2017). Genicot and Ray's (2017) pioneering work introduces the concept of aspirations-based poverty traps, wherein individuals with low levels of aspirations invest less effort than those with higher levels of aspirations, which in turn leads to self-fulfilling low realisation of wealth in the next period. In their conceptualisation, it is not the actual level of the aspiration that matters, but rather the gap between current and aspirational status that determines behaviour. The model is unique as it accounts for the possibility that aspirations could be too high or too low, thus causing frustration and subsequent underinvestment. Janzen et al. (2017) also find strong evidence supporting the inverse-U theory of aspirations failure, wherein very high or very low educational (for own child) and financial aspirations lead to low education and financial investment. Increased aspirations could thus be an important development outcome, not only in itself but also as a determinant of investments in improving one's future outcomes. If programs such as CARE can increase individual's aspirations for themselves and their families, they can be an important catalyst in the adoption of, and investment in, new agricultural practices and technologies, as a pathway towards the realisation of these increased aspirations. In this paper, we focus on absolute aspiration levels and its determinants, rather than aspiration gaps. This is in the spirit of work done by Kosec and Mo (2017) and Bernard and Seyoum Taffesse (2014) using the aspiration index.

3.3 | Behavioural constraints as mediators

We argue that low risk aversion, or alternatively, inclination to take risks, could be an important predictor of the adoption of new practices, including production diversification. We demonstrate this relationship using a directed acyclic graph (Figure 1).

We argue that exposure to CARE interventions or treatment (T) increases both direct outcomes of production and consumption diversity (D) and increased risk-taking (R). However, risk-taking (R) itself could impact the direct outcomes so that the intervention (T) has both a direct effect from T to D and an indirect effect mediated through R. There might be other factors that affect both risk-taking behaviour and direct outcomes (c), such as demographic characteristics, caste and village-level unobservables. We control for these in our specifications. One could argue that there is an additional pathway between T and D, which is affected by selection bias (S) at the individual or village level, such that more enterprising individuals or villages are selected for the intervention. We discuss in detail below, how the construction of a counterfactual or control set of villages was done using preintervention (2011) census data at the village level, and within these village, respondents were chosen at random, minimising the impact of such bias.

4 | SAMPLING STRATEGY, SURVEY DESIGN AND EXPERIMENTAL PROTOCOLS

4.1 | Sampling strategy

To accurately measure program impacts on production, consumption and behaviour, we need a valid counterfactual against which to ascribe program impacts. Since CARE had already been active in these areas for several years, we were not able to randomise program treatments. Our sampling strategy in this study aimed to create a counterfactual group that was similar enough to the treated villages that actual observed treatment status could be perceived as effectively random. More specifically, we used village-level data for the districts of Kandhamal

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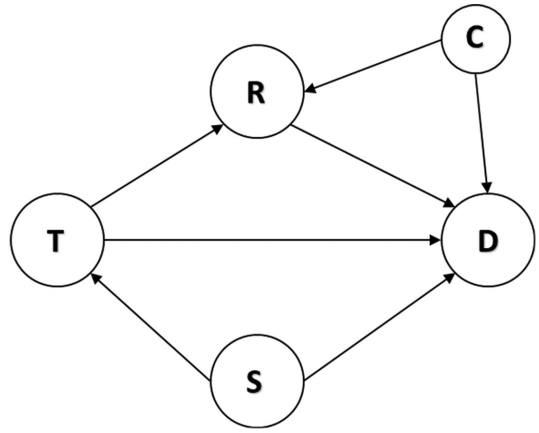

FIGURE 1 Directed acyclic graph depicting the causal pathway between village-level participation in grassroots NGO programming (T) and production and consumption diversity (D). C, control variables; R, risk-taking, S, selection bias. *Source*: Authors.

and Kalahandi in the state of Odisha from the 2011 Census of India (prior to the initiation of CARE's activities in the state) to identify villages that were similar in all attributes apart from the subsequent presence of CARE activities. The following steps were carried out to identify a valid counterfactual for CARE's intervention villages and determine the sampling frame for the study.

First, we used data from the 2011 Census of India to identify all villages from the same administrative blocks (subdistrict administrative units) within which CARE subsequently implemented Pathways and/or TARINA activities. From this list, villages were divided into two groups: those where CARE had subsequently implemented Pathways and/or TARINA activities (these were classified as *treatment* villages) and those where CARE had no active or past programs as of the time of our study (these were classified as *control* villages).

We then estimated propensity scores (predicted probability of treatment by CARE's interventions) for each village using a probit model and a comprehensive list of relevant variables.[4] Using these propensity scores, we used nearest neighbour matching to pair each village later identified as a treatment village with a control village, which had the closest propensity score. This gave us a total of 119 pairs of treatment and control villages. From these, 42 pairs of villages were randomly selected to get an equal number of treatment and control villages, for a total sample of 84 villages. The survey and experiment were conducted between March and May 2018.

In each village, the survey team identified all households actively engaged in agricultural cultivation with the help of the sarpanch (a type of local leader or administrator), and from this list, 12 households were randomly selected for participation in our study. One adult agriculture decision-maker (male or female) and one adult respondent of the opposite gender were interviewed from each household for a total sample of 1960 respondents (980 males and 980 females). In this paper, however, we report results for the 1739 individuals and 865 household decision-makers who completed the risk aversion module. Each interview contained questions on household agricultural practices, consumption, assets and household composition, which

[4]The variables used for propensity score matching included population density, sex ratio, proportion of scheduled caste (SC) households, proportion of scheduled tribe (ST) households, number of schools, access to postal service, presence of pucca [tarmac/asphalt] roads, distance to agricultural credit societies and net sown area. In addition, we matched the villages on the availability of healthcare facilities, ground and surface water irrigation, landline phones, mobile phone coverage, bus and taxi services, tractors, nutritional service, daily newspaper, assembly polling station and power supply for domestic use. See Figure S1 for the distribution of propensity scores between the two groups of villages and Table S7 for balance tests between the control and treatment villages using Census 2011 data.

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was answered by the main agriculture decision-maker in the household. The next set of questions which included the experiments on risk aversion and time preference and ambiguity, as well as questions on decision-making, aspirations and empowerment, were answered by both the respondents.[5] Later that day, or the next day, all the respondents participated in a group game with other respondents in the village.[6]

We recognise that the village-level pairwise matching procedure described here can only account for observable differences between villages, leaving open the possibility of nonobservable heterogeneity. We also recognise that the data used in this analysis are cross-sectional in nature and were collected after the end of Pathways and after the first 2 years of TARINA activities. As a result, treated and control villages and households may differ on the basis of omitted observable variables, unobservable characteristics, or due to intentional targeting or placement bias attributable to CARE, household or individual self-selection into CARE activities, and other factors. Having said that, the matching strategies employed here were the best method available for constructing a counterfactual given the evaluation timeline and the secondary data available.

4.2 | Experimental protocol

4.2.1 | Risk aversion

We used a series of lottery-based experiments to elicit the latent behavioural characteristics related to risk and potential losses. The experiments used in this study were modified from Tanaka et al. (2010), Liu (2013) and Ward and Singh (2015) in their studies of Vietnamese households, Chinese cotton farmers and Indian rice farmers, respectively. The experimental design, which essentially takes the form of a multiple price list (Holt & Laury, 2002), has already been tested among individuals in several different countries, including in several states in India, and is thus simple enough for illiterate or innumerate participants to understand. Our experiments maintain the general design of the Tanaka et al. (2010) and Liu (2013) experiments, with specifically calibrated payouts as well as some additional simplifications to increase the probability of comprehension. A notable difference between our approach and the approaches of Tanaka et al. (2010) or Liu (2013) is that, like Ward and Singh (2015), most of our experiments involve choices between a certain (riskless) payment and a risky prospect. This simplifies the choices participants face, as well as simplifying the estimation of risk premia. The exact experiment protocol is available in the Appendix S1, including the payoff matrices (Tables S3 and S4). We divide our risk preference parameter, σ (defined in Section 3.1), which is measured as the curvature of the value function, into a binary variable with two categories—high risk aversion, which takes the value 1, defined as $0 \leq \sigma < 1.5$ and low risk aversion, $\sigma \geq 1.5$.[7]

4.2.2 | Aspirations and empowerment

To measure women's empowerment and agency in effecting change in agricultural production and technology adoption, we construct an index that is a composite measure of

[5]In this paper, we focus only on risk aversion as these were fully incentive-compatible and played with real money that was handed out after the survey. The experiments on time preference and ambiguity aversion did not involve any monetary reward, were not incentive-compatible and hence are not part of this paper.

[6]The results from the group game are the subject of another paper on cooperation, collective action and altruism.

[7]Those who were among the top 30th percentile of the risk aversion parameter were categorised as having low risk aversion. The bottom 70 percentile were similarly categorised as being highly risk averse. Our findings are robust to different definitions of low and high risk (and loss) aversion, including absolute measures of the risk aversion parameter/value function curvature.

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decision-making power, access to credit and group membership, where each of the components is given equal weight.[8]

We also include a detailed module on aspirations regarding education, assets, income and social status. These aspirations are measured both for the respondents and for their children. We construct an aspiration index, weighting each aspect using self-reported weights. The index is modelled on the index created by Bernard and Seyoum Taffesse (2014) and subsequently used by Kosec and Mo (2017). Respondents are asked a series of questions about their current and aspirational status with regard to four dimensions: income, education, assets and social status. Income and assets are measured in Indian rupees, whereas education is measured as years of schooling. Social status is measured on a progressive 10-point scale. We then gave the respondents 20 beads and asked them to weigh each of the four dimensions based on their perception of its importance in their overall well-being, distributing beads as an indicator of the relative importance.[9] The index is formulated as follows:

$$\text{Aspiration Index}_i = \sum_{k=1}^{4} \left(\frac{a_i^k - \mu^k}{\sigma^k} \right) . \omega_i^k$$

where k is one of the four dimensions mentioned above, a_i^k is respondent i's aspiration on dimension k and μ^k and σ^k measure the sample mean and standard deviation of the response in the sample, and ω_i^k is the weight attached to dimension k.

The other outcome we used to measure aspirations is respondents' hopes for their children's future. We asked respondents what they wanted their children to be when they grow up, and a parent is considered to be aspirational for their children if they *hope* their children will be in a profession other than a homemaker, farmer or labourer. We asked this question separately in regard to the oldest son and oldest daughter of the respondent, though in the present manuscript we report results pertaining to aspirations for daughters only, since the response regarding aspirations for sons had little variation. We then asked respondents about what they *believe* their son and daughter will become in future. We frame this as their *belief* about their child's future, as opposed to their *hope* for the child, which is captured by aspirations. The measure is binary and is coded the same as child aspirations, but again we report results only for daughters owing to very low variation in the responses for sons. Finally, we asked respondents about the aspired level of education for their daughters and sons, measured in years between 0 (no education) and 15 (college).

4.2.3 | Production and consumption diversity

The primary aim of CARE's interventions in the area has been to improve diversity in agricultural production as a means to eventually diversify incomes, consumption and diets. Due to lack of irrigation and winter rain, farmers in Orissa—our area of study—widely practise Rabi fallows, cultivating rice in the monsoon season and leaving their field fallow for the Rabi (winter) cropping season. One of the CARE's primary focuses has been to promote the production of legumes and vegetables in Rabi. We measure the relationship between CARE's interventions and a set of production and consumption diversity using a set of different variables. We first construct a binary measure for whether respondents cultivate in Rabi season or not. Second, we measure whether farmers cultivate pulses in Rabi (binary), one of the main interventions

[8]If the woman makes at least some decisions regarding agricultural production and credit, she receives a score of 1 on decision-making and access to credit, respectively. Similarly, membership in at least one village group gets a score of 1. The scores from all three components are added and divided by 3 to give a score that ranges from a minimum of 0 to a maximum of 1 in increments of 0.33.

[9]Details of the questions used to calculate the aspiration index can be found in the Appendix S1.

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promoted under TARINA. Third, we test for prevalence of pulse cultivation at the intensive margin, through a variable measuring the share of total cultivated area dedicated to pulses. Finally, we measure dietary diversity, calculated on a 12-food group scale using the FAO guidelines on household dietary diversity using a 24-h recall.[10]

4.3 | Descriptive statistics

Over 98% of the households in our sample are male-headed, which is consistent with the largely patriarchal culture and low rates of migration in the area. Around 88% of the respondents in our sample report being household heads or spouses of household heads, and the remainder are predominantly children or children-in-law of the household head. Our survey was conducted in a predominantly tribal area, with households identifying as ST making up 58% of the total population. Together with households identifying as SC, they make up 79% of our sample. Of the two districts where we collected primary data, Kalahandi had a more heterogeneous population, with non-SC/ST making up 30% of the population, compared to 8.9% for Kandhamal

Literacy rates in Odisha are among the lowest in India, and within Odisha, Kalahandi and Kandhamal are among the most illiterate districts. The self-reported literacy rate in our sample was 69% overall and only 55% for women. The average household size in the sample is 5.3 persons with a low overall dependency ratio. The average cultivated area per household is 2.8 acres, with 83% of respondent households, indicating that they cultivated land that they owned, with the remainder cultivating leased land.

5 | RESULTS

We study our results in three stages. In the first stage, we consider the relationship between program implementation and measures of risk preference or risk aversion. We hypothesise that this is the first step towards bringing about a change in other, more direct program outcomes. In the second step, we consider whether the program is associated with changes in outcomes such as aspirations, empowerment and personal agency. Finally, we consider the relationship between the program and direct outcomes that the intervention targeted, such as diversification of production practices and improvements in consumption diversity. In addition, we test whether the association with direct outcomes of consumption and production diversity are mediated by changes in risk preferences. The first two sets of outcomes are analysed at the individual level, while the set of direct outcomes are analysed at the household level (Table 1).

Our estimating equation takes the form

$$Y_{ig} = \alpha + \beta \text{Treatment}_g + \delta Z_{ig} + \epsilon_{ig}, \tag{1}$$

where Y_{ig} refers to the outcome variable of interest for individual or household i from village g (risk aversion, production diversity, consumption diversity, aspirations, etc.); Treatment_g refers to the treatment assignment of village g and takes the 1 for villages that benefitted from CARE's intervention TARINA and/or Pathways, and 0 otherwise; Z_{ig} are the individual and household-level covariates; and ϵ_{ig} is an individual-level error term, clustered at the level of the village. We use ordinary least squares, logit and Poisson regressions to estimate the coefficients of interest as appropriate, and variants of Equation (1) to identify additional impacts. Our findings are robust to alternative specifications of the main estimating equation.

[10]Detailed methodology available at http://www.fao.org/3/i1983e/i1983e00.pdf

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TABLE 1 Balance test.

	Entire sample	Treated	Control	Difference
Male head of household	0.986	0.982	0.989	−0.007
	(0.119)	(0.133)	(0.102)	(0.008)
Head of household	0.484	0.490	0.477	0.014
	(0.500)	(0.500)	(0.500)	(0.009)
Spouse of head	0.411	0.410	0.411	−0.001
	(0.492)	(0.492)	(0.492)	(0.013)
Female	0.504	0.499	0.508	−0.009
	(0.500)	(0.500)	(0.500)	(0.007)
Scheduled caste or scheduled tribe	0.784	0.831	0.735	0.096
	(0.412)	(0.375)	(0.441)	(0.062)
Age	41.904	42.167	41.631	0.536
	(14.133)	(12.700)	(15.484)	(0.972)
Literate 0/1	0.688	0.700	0.674	0.026
	(0.464)	(0.458)	(0.469)	(0.040)
Married	0.957	0.964	0.951	0.013
	(0.202)	(0.187)	(0.216)	(0.012)
Dependency ratio	0.123	0.123	0.123	−0.000
	(0.100)	(0.102)	(0.098)	(0.008)
Household size	5.365	5.301	5.431	−0.130
	(2.079)	(1.937)	(2.216)	(0.141)
Total plot area	2.761	2.690	2.835	−0.145
	(9.879)	(13.567)	(2.810)	(0.557)
Fraction of plot area owned	0.830	0.815	0.845	−0.030
	(0.353)	(0.370)	(0.334)	(0.038)
Household wealth index	0.012	0.013	0.010	0.004
	(0.882)	(0.869)	(0.897)	(0.109)
Risk averse	0.577	0.555	0.601	−0.046
	(0.494)	(0.497)	(0.490)	(0.038)
Aspiration index	0.064	0.150	−0.025	0.175
	(10.446)	(9.329)	(11.495)	(0.847)
Empowerment	0.549	0.571	0.526	0.045
	(0.289)	(0.302)	(0.274)	(0.023)
Member of group	0.357	0.415	0.296	0.119
	(0.479)	(0.493)	(0.457)	(0.034)
Cultivated in Rabi	0.315	0.272	0.359	−0.088
	(0.465)	(0.445)	(0.480)	(0.059)
Household dietary diversity	8.555	8.643	8.464	0.179
	(1.507)	(1.576)	(1.427)	(0.153)
Number of Rabi plots cultivated	0.436	0.353	0.522	−0.169
	(0.760)	(0.657)	(0.846)	(0.094)
N	1739	886	853	1739

Note: Columns (1)–(3) present means and standard deviations of the entire sample, treated sample and control sample, respectively. Figures in Column (4) are coefficient estimates and their associated standard errors (clustered at the village level) from linear regressions of the form $x_{ij} = \alpha + \beta T_i + \epsilon_{ij}$, where x_{ij} is the characteristic over which balance is being tested (i.e. the variable described in the row header) and T_i is an indicator variable capturing the difference in random assignment between treatment and control groups. Statistical significance of these differences was based on a *t*-test of the estimated coefficient β for each household and individual characteristic. *F*-statistic of joint significance is 6.30.

Source: Authors' calculations.

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TABLE 2 Summary of risk aversion parameters.

	Mean	Low risk aversion	High risk aversion	*N*
Value function curvature	0.95	1.50	0.55	1739

Note: Higher values of value function curvature (risk aversion parameter) correspond to lower levels of risk aversion.
Source: Authors' calculations.

5.1 | Risk preference

The experiments described above are specifically designed to disambiguate various dimensions of attitudes about uncertainty, including disambiguating risk aversion, as well as the extent to which perceived probabilities deviate from objective realities when farmers evaluate risky decisions. Here, we study whether the program is associated with reduced aversion to risk. By comparing the average willingness of farmers to take on risk between villages that have previously been beneficiaries of the intervention and those that have not, we find that there are, indeed, systematic differences in farmers' attitudes towards risk, with farmers in villages that have received the intervention being less sensitive to risk and therefore more willing to undertake risky activities. The distribution of the two risk parameters is given in Table 2. On average, the value function curvature of those classified as being less risk averse (or more risk loving) is 1.5 and the overall mean value of σ is 0.95.

We use linear probability models to estimate the effect of treatment on risk aversion.[11] Table 3 shows that treatment has a negative and statistically significant association with the probability of being highly risk averse, implying that farmers in treatment villages are much less likely to be in the high-risk-aversion category. If we assume that these preferences extend beyond monetary payoffs and into other domains, such as agricultural production, then this evidence would largely support the assertion that CARE's programming was associated with relaxing constraints imposed by aversion to risk, and we might therefore expect to see farmers that have benefitted from CARE's activities being more willing to branch out, try new agricultural technologies or undertake practices that are perhaps a little countercultural.

Lowering aversion to risk is important because farmers in general operate in an environment of risk. This is especially true among farmers in developing countries and even more so among farmers in rain-fed production systems who must rely on the vagaries of increasingly uncertain weather. In such risky environments, farmers are often observed to behave in a very conservative fashion, foregoing investments, technologies and practices that could result in higher productivity or profits. As a result, they may become trapped in a low-level development equilibrium. It stands to reason, therefore, that relaxing these constraints and encouraging the adoption of higher risk higher returning technologies and practices, through supportive programs, interventions and information, could be an important avenue by which development practitioners might achieve their objective of encouraging agricultural transformations and the adoption of diverse food production.

5.2 | Aspirations and empowerment

CARE's programs have aimed to improve household nutrition outcomes by educating women about the importance of dietary diversity and empowering them to make decisions

[11]Our results are robust to using other binomial regression specifications. For additional robustness checks and correction for multiple hypothesis testing (see Tables S5 and S6).

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TABLE 3 Risk and loss aversion.

	(1)
	Risk averse
Treated	−0.333***
	(0.0271)
Female	0.058
	(0.0756)
Scheduled caste	0.013
	(0.0459)
Scheduled tribe	0.034
	(0.0500)
Married = 1	−0.046
	(0.0695)
Literate = 1	0.021
	(0.0290)
Age	−0.013**
	(0.0057)
Age squared	0.000**
	(0.0001)
Head of household	0.080
	(0.0759)
Spouse of household head	0.115***
	(0.0409)
Dependency ratio	0.016
	(0.1559)
Household size	−0.007
	(0.0075)
Household wealth index	0.015
	(0.0173)
Plot area owned and operated	−0.009*
	(0.0047)
Constant	0.718***
	(0.1766)
Village fixed effect	Yes
Observations	1739

Note: The results report coefficients from a linear probability model. Column 1 presents the probability of being highly risk averse (1) versus having low risk aversion (0). Standard errors (in parenthesis) are clustered at the village level.

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

Source: Authors' calculations.

about the quality of their family's diet. To assess the efficacy of this approach, we wanted to evaluate the extent to which CARE's interventions improved the level of women's empowerment. To do so, we created a composite measure that can serve as a proxy for empowerment. This index can be concurrently used for both women and men and is a composite measure of decision-making power, access to credit and group membership, with each

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component weighted equally. Thus, a woman who is adequate on all three parameters will score a 1, and another who is inadequate on all three parameters will score a zero.[12] We find that respondents in CARE villages score higher on the index than in control villages (Table 4), and this is especially true for the women-only sample (Table 8). This is perhaps not surprising, since many of CARE's activities are targeted towards empowering women and increasing their agency over productive resources. We also find that respondents in treatment villages were more likely to be members of at least one village group, where village groups are defined as a credit group, self-help group or forest user group. It is to be noted that the probability of being a member in at least one village group is higher even for males in the treated villages, indicating that CARE's promotion of collective action through village groups had positive spillovers for men.[13]

An important—though understudied—outcome is enhancing household members' hopes for their own futures and the futures of their family members, especially their children. These aspirations have increasingly been recognised as an important developmental indicator, as they arguably reflect individuals' hopes for achieving the life they have a reason to value. The aspiration index used in the present study is based on four indicators identified above: education, assets, social status and income. The index is created based on current and aspirational status, and each indicator is weighted based on self-reported weights. The index was then standardised to facilitate easy interpretation.

We find that respondents in treatment villages had a significantly higher value of the aspiration index than in the control group, which is both statistically and qualitatively significant. In addition to aspirations for themselves, we also tested how parents' aspirations for children differed between the control and CARE villages. We define an individual being aspirational for their child if they aspired for their child to be in a profession other than farming, manual labour or being a homemaker. We then ask them what they believed their child will end up becoming, which focusses on their perception of what will happen rather than on what they wish would happen.[14]

We find that in treatment villages, respondents did have higher aspirations for their daughters, and compared with the control, they also had stronger positive beliefs about their daughter's future profession (Table 5). We also test whether the aspired level of education differed between treatment and control villages and find that for both boys and girls, respondents in treatment villages had a higher level of aspirations for their children's years of education.

5.3 | Production and consumption diversity

In this section, we examine how effective the interventions have been in changing direct program outcomes of production and consumption diversity. In the previous section, behavioural outcomes and preferences were analysed at the individual level; however, since production and consumption decisions are made by the household, we consider the household as the unit of analysis for this section.

However, we find that households in treated villages are no more likely to cultivate in Rabi compared with households in control villages. However, among the subset of farmers who do

[12]While this measure draws elements from the Women's Empowerment in Agriculture Index (WEAI), it is in no way as comprehensive as the WEAI, nor is it a validated instrument. The results here are illustrative of the broader impacts of the intervention on women's empowerment as measured by participation in village groups, access to credit and agriculture decision-making.

[13]Results for male subsample available on request.

[14]Belief, like aspiration is a binary variable equal to one if the respondent believes their daughter will be in a profession other than farming or manual labour.

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TABLE 4 Aspirations and empowerment.

	(1)	(2)	(3)
	Aspiration index	**Empowerment index**	**Member of village group (0/1)**
Treated	2.90***	0.19***	0.46***
	(0.522)	(0.017)	(0.024)
Female	−4.76***	0.07*	0.11*
	(1.440)	(0.040)	(0.056)
Scheduled caste	2.03**	0.00	0.04
	(0.872)	(0.026)	(0.049)
Scheduled tribe	−1.04	0.02	0.02
	(0.741)	(0.023)	(0.042)
Married = 1	−1.37	0.08**	0.05
	(1.428)	(0.040)	(0.058)
Literate = 1	4.77***	0.07***	0.11***
	(0.578)	(0.019)	(0.030)
Age	−0.25**	0.02***	0.03***
	(0.113)	(0.004)	(0.005)
Age squared	0.00	−0.00***	−0.00***
	(0.001)	(0.000)	(0.000)
Head of household	−3.41**	0.02	−0.07
	(1.512)	(0.044)	(0.058)
Spouse of household head	−0.68	0.05*	0.09**
	(0.952)	(0.029)	(0.046)
Dependency ratio	1.29	0.04	−0.12
	(2.734)	(0.100)	(0.162)
Household size	−0.09	0.00	0.01
	(0.118)	(0.004)	(0.007)
Household wealth index	2.62***	0.00	0.02
	(0.379)	(0.010)	(0.015)
Plot area owned and operated	0.70***	0.00	0.00
	(0.083)	(0.003)	(0.006)
Constant	7.10**	−0.16*	−0.68***
	(2.775)	(0.084)	(0.122)
Village fixed effect	Yes	Yes	Yes
Observations	1739		

Note: The results report coefficients from an ordinary least squares regression. Aspiration index is measured as detailed in Section 4.2.2. The empowerment index takes values between 0 and 1 and is a composite measure of adequacy in decision-making about productive assets (0/1), access to credit (0/1) and membership in village groups (0/1), with each of three components weighted equally. Standard errors (in parenthesis) are clustered at the village level.

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

Source: Authors' calculations.

cultivate a crop in Rabi, farmers in treated villages are 20 percentage points more likely to grow pulses. We find that even in Kharif, the main cropping season, farmers in villages where CARE is active are more likely to have a slightly larger proportion of their land dedicated to pulses indicating a small but significant diversification away from staple grains, towards

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TABLE 5 Aspirations for children.

	(1)	(2)	(3)	(4)
	Aspirational for daughter (0/1)	**Belief for daughter (0/1)**	**Aspired years of education (son)**	**Aspired years of education (daughter)**
Treated	0.14***	0.28***	1.91***	2.62***
	(0.029)	(0.040)	(0.154)	(0.202)
Female	0.07	−0.10	0.17	−0.81
	(0.065)	(0.100)	(0.450)	(0.660)
Scheduled caste	0.13***	0.08*	0.44**	0.54*
	(0.039)	(0.048)	(0.188)	(0.302)
Scheduled tribe	0.07**	0.07	0.40*	0.13
	(0.033)	(0.053)	(0.208)	(0.265)
Married = 1	0.26**	0.17	0.56	0.64
	(0.124)	(0.118)	(0.396)	(0.556)
Literate = 1	0.11***	0.12***	0.25*	0.79***
	(0.033)	(0.037)	(0.136)	(0.204)
Age	0.00	−0.00	0.01	0.06
	(0.007)	(0.009)	(0.034)	(0.045)
Age squared	−0.00	−0.00	−0.00	−0.00***
	(0.000)	(0.000)	(0.000)	(0.001)
Head of household	0.04	−0.09	0.08	−0.84
	(0.081)	(0.117)	(0.440)	(0.629)
Spouse of household head	−0.04	−0.10	0.15	0.27
	(0.058)	(0.073)	(0.295)	(0.361)
Dependency ratio	−0.01	0.56***	0.64	−0.52
	(0.155)	(0.211)	(0.792)	(1.019)
Household size	−0.01	−0.03**	−0.08**	−0.06
	(0.009)	(0.012)	(0.039)	(0.054)
Household wealth index	0.05**	0.07***	0.25***	0.47***
	(0.020)	(0.023)	(0.093)	(0.131)
Plot area owned and operated	0.00	0.00	0.08***	0.13***
	(0.006)	(0.007)	(0.022)	(0.041)
Constant	0.41*	0.89***	12.36***	11.11***
	(0.207)	(0.242)	(1.073)	(1.443)
Village fixed effect	Yes	Yes	Yes	Yes
Observations	1123	1123	1328	1108

Note: The results report coefficients from an ordinary least square regression linear probability model for Columns 1 and 2). Aspiration (belief) is coded as 1 if parent aspires (believes) the daughter to have (will have) a profession other than farmer, labourer or homemaker. Standard errors (in parenthesis) are clustered at the village level. Sample includes only those respondents who had at least one daughter and/or son.

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

Source: Authors' calculations.

nutrient-dense crops. We find CARE's interventions are positively associated with consumption diversity as well. In treatment villages, household dietary diversity was higher (0.27 food group) than in the control (Table 6).

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TABLE 6 Production and consumption diversity.

	(1)	(2)	(3)	(4)
	Cultivated in Rabi (0/1)	**Cultivated pulses in Rabi (0/1)**	**Fraction of plot area for pulses in Kharif**	**Household dietary diversity score**
Treated	0.04	0.21***	0.04*	0.28**
	(0.047)	(0.074)	(0.021)	(0.109)
Scheduled caste	−0.05	0.03	0.03	−0.26*
	(0.060)	(0.067)	(0.018)	(0.142)
Scheduled tribe	0.01	0.13*	0.00	−0.13
	(0.050)	(0.074)	(0.014)	(0.138)
Household head married = 1	0.12	−0.00	−0.01	0.19
	(0.078)	(0.108)	(0.025)	(0.271)
Head literate = 1	0.01	0.06	0.02	0.33**
	(0.046)	(0.071)	(0.015)	(0.145)
Age of head	0.02**	−0.01	0.00	−0.01
	(0.008)	(0.017)	(0.003)	(0.022)
Age of head squared	−0.00**	0.00	−0.00	0.00
	(0.000)	(0.000)	(0.000)	(0.000)
Dependency ratio	−0.23	−0.07	−0.07	−0.12
	(0.186)	(0.260)	(0.065)	(0.633)
Household wealth index	0.07***	−0.08**	−0.01**	0.47***
	(0.019)	(0.033)	(0.006)	(0.060)
Total plot area owned and operated	0.02*	0.02*	0.00**	0.06***
	(0.009)	(0.009)	(0.002)	(0.015)
Household size	0.00	0.01	0.00	0.03
	(0.010)	(0.014)	(0.003)	(0.026)
Constant			−0.08	
			(0.077)	
Block fixed effect	Yes	Yes	Yes	Yes
Observations	865	251	865	865

Note: Columns (1) and (2) report marginal effects from a logit regression. Column (3) reports coefficients from an ordinary least squares regression. Column (4) reports marginal effects from a Poisson regression. For (2), results are restricted to those farmers who cultivate in Rabi and a Heckman sample selection test finds no selection bias among those farmers who chose to cultivate in Rabi and those who do not. Dietary diversity (4) is measured on a 12-food group scale using the FAO guidelines on household dietary diversity using a 24-h recall. Results remain consistent if regressions in Columns (1), (2) and (4) are done using ordinary least squares. Standard errors (in parenthesis) are clustered at the village level.

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

Source: Authors' calculations.

5.4 | Mediation analysis

We have previously discussed how risk preferences are positively associated with CARE's interventions. This could be due to increased access to agriculture information, establishment and revitalisation of village groups, enhanced availability of postharvest storage facilities and improved access to information and resources for livelihood diversification, all of which could

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increase an individual's ability to undertake risk. We also see that the intervention had a direct positive association with household production and consumption diversity, which was the central aim of the interventions. However, we do not know whether or how this relationship was mediated by changes in risk preferences.

For mediation analysis to be valid, we rely on three central assumptions (Ward et al., 2020). First, the treatment must impact the outcome without differentiating between the direct and indirect impact. Second, the treatment must also impact the mediating variable, in our case risk aversion, to show that treatment predicts the mediator. Finally, after controlling for the mediator, the impact of treatment on outcome should be attenuated and the coefficient on the mediator should be statistically significant. We check for all these in turn. Since the outcomes of production and consumption diversity were answered by the main agriculture decision-maker in the household, we restrict the sample only to include those who answered the production and consumption diversity module. Table 7 shows that indeed, even within this restricted sample, treatment was a significant predictor of both risk aversion and consumption and production diversity. This satisfies Conditions 1 and 2. To test whether our mediation hypothesis holds, we re-estimate the main specification, also controlling for risk aversion (the mediator). In this case, we find that while the impact of treatment was indeed attenuated, the coefficient on risk aversion remains insignificant (Table 8). This implies that at least within the time period we were studying, changes in production and consumption diversity as a result of CARE interventions may not have been mediated by changes in risk preference, even though the program was successful in reducing aversion to risk-taking.

6 | HETEROGENEITY ANALYSIS

Since the intervention we study was focussed largely on women, we test whether the treatment was effective in changing outcomes for women by looking at the women-only subsample. Hitherto, there has been wide agreement in the literature that women are more risk averse than men when confronted with decisions under uncertainty. In economics, for instance, Eckel and Grossman, 2002 and Croson and Gneezy (2009) find evidence supporting this along several dimensions, such as characteristics of the subject pool, strength of incentives, comparing gain and loss domains, and abstract versus contextual frameworks. Charness and Gneezy (2012) focus on a single elicitation method, the Investment Game, and find strong evidence that females are less willing to take risk. In psychology, Byrnes et al. (1999) using a broad definition of risk, from smoking to driving and gambling, analyse self-reported, incentivised as well as observed choices in a meta-analysis of 150 studies and find that males take more risks than females in most of the risk categories.

There are some recent studies that disagree with this previously established finding. A recent study by Filippin and Crosetto (2016) finds that gender differences in risk preferences are more of an exception than a rule. Using the Holt and Larry risk elicitation method, similar to the method used in our analysis, they find that the likelihood of observing gender differences crucially depends on the features of the task used to elicit risk preferences and in particular, on the availability of a safe option and fixed probabilities. Likewise, Fisher and Yao (2017) find that gender differences in financial risk tolerance result from differences in the relationship between several independent variables—economic characteristics, demographic characteristics and expectations—and risk tolerance for men and women, rather than gender itself. They argue that these variables serve as moderating variables in the relationship between gender and risk tolerance. Nelson (2016) also argues that widespread acceptance of statements like 'women are more risk averse than men' appears to be rooted more in confirmation bias than in reality. As Table 3 shows, in our study as well, we find

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TABLE 7 Mediation analysis: first stage.

	(1)	(2)	(3)	(4)
Direct Outcome	**Cultivated in Rabi (0/1)**	**Cultivated pulses in Rabi (0/1)**	**Fraction of plot area for pulses in Kharif**	**Household dietary diversity score**
Treated	0.04	0.16**	0.04*	0.28**
	(0.047)	(0.078)	(0.019)	(0.108)
Mediator	Risk Averse			
Treated	−0.097**			
	(0.0424)			
Observations	865	275	865	865

Note: In all four columns, the results report coefficients from ordinary least squares estimation. In Column 1, Panel 2 presents the probability of being highly risk averse (1) versus having low risk aversion (0) for the main agriculture decision-maker of the household. Standard errors (in parenthesis) are clustered at the village level. All regressions control for household wealth, plot area owned, household size, caste and household head characteristics, and other individual or household characteristics. Individual-level regressions control for village fixed effects and household-level variables control for block fixed effects.

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

Source: Authors' calculations.

TABLE 8 Mediation analysis.

	(1)	(2)	(3)	(4)
	Cultivated in Rabi (0/1)	**Cultivated pulses in Rabi (0/1)**	**Fraction of plot area for pulses in Kharif**	**Household dietary diversity score**
Risk averse	−0.01	−0.08*	−0.00	−0.16
	(0.029)	(0.044)	(0.011)	(0.110)
Treated	0.04	0.17**	0.04*	0.29***
	(0.067)	(0.079)	(0.021)	(0.109)
Risk averse	−0.03	−0.05	−0.02	−0.22
	(0.044)	(0.058)	(0.016)	(0.137)
Treated	0.02	0.20**	0.03	0.22
	(0.066)	(0.097)	(0.019)	(0.161)
Risk averse × Treated	0.04	−0.05	0.03	0.12
	(0.062)	(0.088)	(0.022)	(0.211)
Observations	865	275	865	865

Note: The results report coefficients from ordinary least squares estimation. Standard errors (in parenthesis) are clustered at the village level. For (2), results are restricted to those farmers who cultivate in Rabi, and a Heckman sample selection test finds no selection bias among those farmers who chose to cultivate in Rabi and those who do not. All regressions control for household wealth, household land ownership, household size, dependency ratio, caste, household head characteristics and block fixed effects.

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

Source: Authors' calculations.

no difference in the risk preference between men and women, both by itself and when controlling for other confounding variables.

However, we find that the program is associated strongly with relaxing risk aversion among women. Table 9 shows that women in the treatment group have a much lower probability of being in the high-risk-aversion category than those having low levels of risk aversion.

The program also has a strong positive association with women's aspirations. We find that women in treated villages had a significantly higher aspiration index z-score than in the

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TABLE 9 Risk aversion—female subsample.

	(1)
	High risk aversion
Treated	−0.523***
	(0.0360)
Scheduled caste	−0.039
	(0.0641)
Scheduled tribe	0.020
	(0.0697)
Married = 1	−0.109
	(0.0835)
Literate = 1	0.037
	(0.0449)
Age	−0.007
	(0.0082)
Age squared	0.000
	(0.0001)
Head of household	−0.079
	(0.1101)
Spouse of household head	0.054
	(0.0501)
Dependency ratio	0.303
	(0.2119)
Household size	−0.016
	(0.0114)
Household Wealth Index	0.030
	(0.0252)
Plot area owned and operated	−0.009
	(0.0079)
Constant	0.960***
	(0.1985)
Village fixed effect	Yes
Observations	875

Note: The results report coefficients from a linear probability model. Column 1 presents the probability of being highly risk averse (1) versus having low risk aversion (0). Standard errors (in parenthesis) are clustered at the village level.

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

Source: Authors' calculations.

control and were also more likely to score higher on the empowerment index. The probability of women in the treatment group being active members of at least one village group was also 37% higher than in control (Table S1).

In addition to the outcomes for themselves, we also test whether the treatment had any association with women's aspirations for their children. We find that women in the treated group were likely to aspire to more years of schooling for their sons and daughters and more likely to believe that their daughter would be in a nonfarm, nonmanual labour profession (Table S2).

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7 | POLICY IMPLICATIONS AND CONCLUSION

This paper studies the impact of a large agriculture program that aimed to improve livelihoods and nutrition through the promotion of production diversification away from staple grains and towards more nutrient-dense crops such as pulses and vegetables. A large part of the program was targeted towards women by using behaviour change communication disseminated through village and self-help groups. We first study whether the program was associated with relaxed behavioural constraints around risk aversion using field experiments and survey-based diagnostics. We also study the relationship of the program with direct outcomes such as production and consumption diversity and indirect outcome measures such as empowerment and aspiration. We find that respondents in treatment villages are much more willing to take on risk, thus offering evidence that the program was associated with lower aversion to risk among the treated individuals. However, we find that the positive relationship of the intervention with production and consumption diversity was not mediated by a reduction in risk aversion. Overall, we find the interventions were associated with improved women's empowerment and aspirations, which is also reflected in higher aspirations for girls. Higher aspirations are the first step towards better outcomes, and future monitoring should focus on measuring how these aspirations convert into action as the program matures. In addition to increasing farmers' willingness to accept risks, increasing community engagement and increasing women's empowerment, the evidence suggests that the intervention may have had broader positive effects, such as increasing active participation in village groups. In intervention villages, both men and women were much more likely to be active participants in community groups. This is encouraging since the intervention has focussed extensively on group-based activities and messaging towards promoting collective action.

Translating these findings into scalable programs is challenging, but the findings of our study offer some guidelines for designing interventions that aim to change fundamental behavioural preferences. Most importantly, our results show that social development and grassroots approaches are effective in inducing a shift towards changing production systems. A recommended programmatic first step is to build upon areas where community social development programming already exists. As an example, recent research points towards the relative success of leveraging self-help groups formed under India's National Rural Livelihoods Mission (NRLM) in increasing knowledge about nutrition and agriculture (Raghunathan et al., 2018).

Our experiments also help identify heterogeneous differences in behaviour between men and women, which can guide more targeted interventions. We find CARE's interventions are positively associated with ancillary measures, such as empowerment and aspirations, especially for women. This is suggestive of the potentially broad reaching influence of the project, beyond proximate outputs. Insights into the prevalence of behavioural constraints and interventions that relax such constraints fill an important knowledge gap in how to design programs that promote a variety of development interventions and remain a topic of further research and enquiry.

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DATA AVAILABILITY STATEMENT

All data and code associated with this paper can be made available on request.

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REFERENCES

Ambler, K. & De Brauw, A. (2017) *The impacts of cash transfers on women's empowerment: learning from Pakistan's BISP program (Social protection and Labor Discussion Paper No. 1702)*, Washington, DC.

Ayenew, H.Y., Biadgilign, S., Schickramm, L., Abate-Kassa, G. & Sauer, J. (2018) Production diversification, dietary diversity and consumption seasonality: panel data evidence from Nigeria. *BMC Public Health*, 18(1), 988. Available from: https://doi.org/10.1186/s12889-018-5887-6

Bernard, T. & Seyoum Taffesse, A. (2014) Aspirations: an approach to measurement with validation using Ethiopian data. *Journal of African Economies*, 23(2), 189–224. Available from: https://doi.org/10.1093/jae/ejt030

Binswanger, H.P. (1980) Attitudes toward risk: experimental measurement in rural India. *American Journal of Agricultural Economics*, 62(179), 395–407.

Brick, K. & Visser, M. (2015) Risk preferences, technology adoption and insurance uptake: a framed experiment. *Journal of Economic Behavior & Organization*, 118, 383–396. Available from: https://doi.org/10.1016/J.JEBO.2015.02.010

Byrnes, J.P., Miller, D.C. & Schafer, W.D. (1999) Gender differences in risk taking: a meta-analysis. *Psychological Bulletin*, 125(3), 367–383. Available from: https://doi.org/10.1037/0033-2909.125.3.367

CARE. (2018) *India | Pathways to Secure Livelihoods*. Available from: http://www.carepathwaystoempowerment.org/portfolio-view/india/ [Accessed 15th January 2023].

Charness, G. & Gneezy, U. (2012) Strong evidence for gender differences in risk taking. *Journal of Economic Behavior & Organization*, 83(1), 50–58. Available from: https://doi.org/10.1016/J.JEBO.2011.06.007

Cornish, L. (2018) *How empowering women leads to innovative agricultural practices | Devex*. Available from: https://www.devex.com/news/how-empowering-women-leads-to-innovative-agricultural-practices-92236 [Accessed 15th January 2023].

Croson, R. & Gneezy, U. (2009) Gender differences in preferences. *Journal of Economic Literature*, 47(2), 448–474. Available from: https://doi.org/10.1257/jel.47.2.448

Diiro, G.M., Seymour, G., Kassie, M., Muricho, G. & Muriithi, B.W. (2018) Women's empowerment in agriculture and agricultural productivity: evidence from rural maize farmer households in western Kenya. *PLoS One*, 13(5), e0197995. Available from: https://doi.org/10.1371/journal.pone.0197995

Dillon, A., McGee, K. & Oseni, G. (2015) Agricultural production, dietary diversity and climate variability. *The Journal of Development Studies*, 51(8), 976–995.

Eckel, C.C. & Grossman, P.J. (2002) Sex differences and statistical stereotyping in attitudes toward financial risk. *Evolution and Human Behavior*, 23(4), 281–295. Available from: https://doi.org/10.1016/S1090-5138(02)00097-1

Favara, M. (2017) Do dreams come true? Aspirations and educational attainments of Ethiopian boys and girls. *Journal of African Economies*, 26(5), 561–583. Available from: https://doi.org/10.1093/jae/ejx018

Filippin, A. & Crosetto, P. (2016) A reconsideration of gender differences in risk attitudes. *Management Science*, 62(11), 3138–3160. Available from: https://doi.org/10.1287/mnsc.2015.2294

Fisher, P.J. & Yao, R. (2017) Gender differences in financial risk tolerance. *Journal of Economic Psychology*, 61, 191–202. Available from: https://doi.org/10.1016/J.JOEP.2017.03.006

Foltz, J.D. (2003) The economics of water-conserving technology adoption in Tunisia: an empirical estimation of farmer technology choice. *Economic Development and Cultural Change*, 51(2), 359–373. Available from: https://doi.org/10.1086/367627

Genicot, G. & Ray, D. (2017) Aspirations and inequality. *Econometrica*, 85(2), 489–519. Available from: https://doi.org/10.3982/ECTA13865

Glewwe, P. (1999) Why does mother's schooling raise child health in developing countries? Evidence from Morocco. *The Journal of Human Resources*, 34(1), 124. Available from: https://doi.org/10.2307/146305

Haddad, L. (2000) A conceptual framework for assessing agriculture–nutrition linkages. *Food and Nutrition Bulletin*, 21(4), 367–373. Available from: https://doi.org/10.1177/156482650002100405

14678489, 2024, 1, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/1467-8489.12535 by UNIVERSITY OF MINNESOTA 170 WILSON LIBRARY, Wiley Online Library on [16/04/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Hirvonen, K. & Hoddinott, J. (2017) Agricultural production and children's diets: evidence from rural Ethiopia. *Agricultural Economics*, 48(4), 469–480. Available from: https://doi.org/10.1111/AGEC.12348

Holt, C. & Laury, S. (2002) Risk aversion and incentive effects. *American Economic Review*, 92(5), 1644–1655.

Janzen, S.A., Magnan, N., Sharma, S. & Thompson, W.M. (2017) Aspirations failure and formation in rural Nepal. *Journal of Economic Behavior & Organization*, 139, 1–25. Available from: https://doi.org/10.1016/J.JEBO.2017.04.003

Just, R.E. (1975) Risk aversion under profit maximization. *American Journal of Agricultural Economics*, 57(2), 347–352. Available from: https://doi.org/10.2307/1238513

Kahneman, D. & Tversky, A. (1979) Prospect theory: an analysis of decision under risk. *Econometrica*, 47(2), 263–292.

Kebede, H.A. (2022) Market integration and separability of production and consumption decisions in farm house holds. *Journal of Development Economics*, 158, 102939. Available from: https://doi.org/10.1016/j.jdeveco.2022.102939

Koppmair, S., Kassie, M. & Qaim, M. (2017) Farm production, market access and dietary diversity in Malawi. *Public Health Nutrition*, 20(2), 325–335. Available from: https://doi.org/10.1017/S1368980016002135

Kosec, K. & Mo, C.H. (2017) Aspirations and the role of social protection: evidence from a natural disaster in rural Pakistan. *World Development*, 97, 49–66. Available from: https://doi.org/10.1016/J.WORLDDEV.2017.03.039

Kumar, N., Harris, J. & Rawat, R. (2015) If they grow it, will they eat and grow? Evidence from Zambia on agricultural diversity and child undernutrition. *The Journal of Development Studies*, 51(8), 1060–1077.

Liu, E.M. (2013) Time to change what to sow: risk preferences and technology adoption decisions of cotton farmers in China. *Review of Economics and Statistics*, 95(4), 1386–1403.

Llewellyn, R.S. & Brown, B. (2020) Predicting adoption of innovations by farmers: what is different in smallholder agriculture? *Applied Economic Perspectives and Policy*, 42(1), 100–112. Available from: https://doi.org/10.1002/aepp.13012

Lovo, S. & Veronesi, M. (2019) Crop diversification and child health: empirical evidence from Tanzania. *Ecological Economics*, 158, 168–179. Available from: https://doi.org/10.1016/J.ECOLECON.2019.01.005

Lybbert, T.J. & Wydick, B. (2018) Poverty, aspirations, and the economics of hope. *Economic Development and Cultural Change*, 66(4), 709–753. Available from: https://doi.org/10.1086/696968

Malapit, H.J.L. & Quisumbing, A.R. (2015) What dimensions of women's empowerment in agriculture matter for nutrition in Ghana? *Food Policy*, 52, 54–63. Available from: https://doi.org/10.1016/J.FOODPOL.2015.02.003

Mottaleb, K.A. (2018) Perception and adoption of a new agricultural technology: evidence from a developing country. *Technology in Society*, 55, 126–135. Available from: https://doi.org/10.1016/j.techsoc.2018.07.007

Nelson, J.A. (2016) Not-so-strong evidence for gender differences in risk taking. *Feminist Economics*, 22(2), 114–142. Available from: https://doi.org/10.1080/13545701.2015.1057609

Palis, F.G. (2006) The role of culture in farmer learning and technology adoption: a case study of farmer field schools among rice farmers in Central Luzon, Philippines. *Agriculture and Human Values*, 23, 491–500. Available from: https://doi.org/10.1007/s10460-006-9012-6

Pellegrini, L. & Tasciotti, L. (2014) Crop diversification, dietary diversity and agricultural income: empirical evidence from eight developing countries. *Canadian Journal of Development Studies / Revue Canadienne d'études Du Développement*, 35(2), 211–227. Available from: https://doi.org/10.1080/02255189.2014.898580

Pingali, P. (2015) Agricultural policy and nutrition outcomes – getting beyond the preoccupation with staple grains. *Food Security*, 7(3), 583–591. Available from: https://doi.org/10.1007/s12571-015-0461-x

Quisumbing, A., Montalvao, J. & Goldstein, M. (2019) *Is empowering women in agricultural development projects worth the investment? Yes, when done right*. Available from: https://www.ifpri.org/blog/empowering-women-agricultural-development-projects-worth-investment-yes-when-done-right [Accessed 15th January 2023].

Raghunathan, K., Kannan, S. & Quisumbing, A.R. (2018) *Women's self-help groups, decision-making, and improved agricultural practices in India: from extension to practice* (IFPRI Discussion Paper No. 1735), Washington, DC. https://doi.org/10.2499/1046080777

Salazar, L. & Fahsbender, J. (2018) *How two agricultural development projects boosted women's empowerment*. Available from: https://www.ifpri.org/blog/how-two-agricultural-development-projects-boosted-womens-empowerment [Accessed 15th January 2023].

Seymour, G. (2017) Women's empowerment in agriculture: implications for technical efficiency in rural Bangladesh. *Agricultural Economics*, 48(4), 513–522. Available from: https://doi.org/10.1111/agec.12352

Shively, G. & Sununtnasuk, C. (2015) Agricultural diversity and child stunting in Nepal. *Journal of Development Studies*, 51(8), 1078–1096.

Sibhatu, K.T. & Qaim, M. (2018) Review: Meta-analysis of the association between production diversity, diets, and nutrition in smallholder farm households. *Food Policy*, 77, 1–18. Available from: https://doi.org/10.1016/j.foodpol.2018.04.013

Tanaka, T., Camerer, C.F. & Nguyen, Q. (2010) Risk and time preferences: linking experimental and household survey data from Vietnam. *American Economic Review*, 100(1), 557–571.

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TARINA. (2018) *Food systems approach – technical assistance and research for Indian Nutrition and Agriculture*. Available from: https://tarina.tci.cornell.edu/about-us/food-systems-approach/ [Accessed 1st March 2023].
Thomas, D. (1994) Like father, like son; like mother, like daughter: parental resources and child height. *The Journal of Human Resources*, 29(4), 950. Available from: https://doi.org/10.2307/146131
Tversky, A. & Kahneman, D. (1992) Advances in prospect theory: cumulative representation of uncertainty. *Journal of Risk and Uncertainty*, 5(4), 297–323.
Waqas, M. & Awan, M.S. (2019) Do cash transfers effect women empowerment? Evidence from Benazir income support program of Pakistan. *Women's Studies*, 48(7), 777–792. Available from: https://doi.org/10.1080/00497878.2019.1666007
Ward, P.S. & Singh, V. (2015) Using field experiments to elicit risk and ambiguity preferences: behavioural factors and the adoption of new agricultural technologies in rural India. *Journal of Development Studies*, 51(6), 707–724.
Ward, P.S., Alvi, M.F., Makhija, S. & Spielman, D.J. (2020) Cooperation and the management of local commonresources in remote rural communities: Evidence from Odisha, India. IFPRIDiscussion Paper 1940. Washington, DC: International Food Policy ResearchInstitute (IFPRI). https://doi.org/10.2499/p15738coll2.133790
Wuepper, D. & Lybbert, T.J. (2017) Perceived self-efficacy, poverty, and economic development. *Annual Review of Resource Economics*, 9(1), 383–404. Available from: https://doi.org/10.1146/annurev-resource-100516-053709
Wyckhuys, K.A.G. & O'Neil, R.J. (2010) Social and ecological facets of pest management in Honduran subsistence agriculture: implications for IPM extension and natural resource management. *Environment, Development and Sustainability*, 12(3), 297–311. Available from: https://doi.org/10.1007/s10668-009-9195-2
Yesuf, M. & Bluffstone, R.A. (2009) Poverty, risk aversion, and path dependence in low-income countries: experimental evidence from Ethiopia. *American Journal of Agricultural Economics*, 91(4), 1022–1037.

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