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What resilience theory and praxis can learn from multi-dimensional approaches to understanding poverty: A study of Ghanaian cocoa forest landscapes

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ABSTRACT

Resilience – broadly understood as withstanding, and adapting to, shocks and risks – has emerged as a central discursive device for converging humanitarian needs with climate change responses. This paper's human-centred engagement with resilience draws on the case of smallholder farmers engaged in rain-fed cocoa production in Ghana's Central Region, to systematically unpack how poverty shapes smallholders' responses to drought, with differing effects on resilience. The surveys, focus groups, and interviews were gathered before, during, and in the aftermath of, a prolonged El Niño-induced drought, facilitating pre-drought and post-drought comparisons of poverty conditions and their interactions with resilience. We centre our analysis on smallholders' definitions of both poverty and resilience. We consider how co-identified dimensions of poverty interact with three co-identified dimensions or "outcomes" of resilience: i) meeting critical needs; ii) implementing adaptation; and iii) preparedness for future climate shocks. We find that higher cocoa incomes were *not* associated with meeting critical needs during a drought, while many other poverty indicators were important across different dimensions of resilience e.g., adequate healthcare access, access to clean drinking water, food security, livelihood diversification, and access to livestock. Thus we advocate that: resilience, like poverty be understood and addressed as multi-dimensional; that resilience be considered in tandem with people's own livelihood concerns; and that interventions look beyond raising cash crop productivity. Although diversifying income is a common resilience-boosting policy, we found greater livelihood diversification was associated with *lower* preparedness scores and meeting *fewer* critical needs in the drought year. Income diversification's ability to alleviate multiple dimensions of poverty is constrained by financial exclusion, lack of market linkages, and structural poverty barriers such as illiteracy, tenure insecurity, or non-potable water. Thus efforts to address households' poverty and climate resilience must be holistic and responsive to local contexts.

1. Introduction

For smallholder farmers in rain-fed systems, the impacts of climate change and individual climate shocks can be severe, direct, and inescapable (Cooper et al., 2008; Osumanu, 2022; Rockström, 2003). In sub-Saharan African (SSA) countries, temperature increases, rainfall variability, and droughts are predicted to increase in frequency and intensity in coming decades (IPCC, 2021; Lottering et al., 2020; Yaro,

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2013); thereby jeopardising food security and livelihoods, and deepening humanitarian challenges (Challinor et al., 2007; Thornton et al., 2011). Against this backdrop of increasing climate change, along with persistent poverty across the Global South and especially rural SSA, the concept of climate resilience – widely defined as the ability to withstand and adapt to climatic risks and shocks (Adger et al., 2005; Folke, 2016) – has gained significant policy traction in economic-development interventions (Béné et al., 2016, Béné et al., 2012; World Bank, 2018). Each iteration of the Intergovernmental Panel on Climate Change's (IPCC's) Assessment Report has identified that in terms of biophysical exposure, finances, and formal resources, rain-dependent SSA farmers are severely disadvantaged. Despite long-term recognition of the links between climate impacts, poverty, and resilience, many resilience models fail to appraise their interconnected complexities (Lade et al., 2017), as have resilience interventions (Eriksen et al., 2021; Leal Filho et al., 2021). The pursuit of resilience often overlooks structural and intersectional determinants of vulnerability and poverty (Jackson, 2024). Theoretical and empirical engagement of the relationship between resilience and poverty remains extremely limited.

The prominence of resilience across economic-development interventions is reflected in the Global Resilience Partnership funded by prominent international aid organisations, and by the World Bank Action Plan for Climate Change Adaptation and Resilience to "manage risks for a more resilient future" by providing $50 billion between 2021 and 2025 for direct climate finance across the Global South (World Bank, 2019; Matthews, 2020). Although some resilience interventions failed to serve poor people's needs (Leal Filho et al., 2021), and even *increased* vulnerabilities (Eriksen et al., 2021), resilience has almost usurped poverty alleviation as development's primary goal (Barrett and Constas, 2014; Frankenberger et al., 2014; Mikulewicz and Taylor, 2020). Resilience's rise is also evidenced by the COP's Resilience Hub and 'Race to Resilience' campaign which aim to "strengthen the resilience of 4 billion people" (UNFCCC, 2021); though how resilience across four billion diverse people living in diverse contexts is assessed remains unspecified. Without either meaningfully considering affected people's experiences of climate impacts, or epistemic shifts that normatively ask 'what is being maintained and for whom?' (Cretney, 2014; Cutter, 2016; Quandt and Paderes, 2023), resilience interventions risk entrenching poverty and exacerbating inequalities (Bahadur and Tanner, 2014; Matin et al., 2018). Despite poverty and resilience's interconnections, there remains a lack of research asking: i) 'how does poverty undermine resilience?', or ii) 'which dimensions of poverty influence resilience?'. This paper probes these questions by embedding the study of resilience within lived experiences of poverty.

Climate change multiplies existing disadvantages (Maru et al., 2014). One climate shock event can further impoverish poorly-resourced people, push individuals deeper into poverty, or lock them into poverty traps, and/or maladaptive practices (Asare-Nuamah et al., 2021; Tongruksawattana and Wainaina, 2019). The 2015–2016 El Niño, which forms the focus of this study, is one such climate shock. Ghanaian cocoa smallholders, who produce ~20 % of the world's cocoa (ICCO, 2020; Van Huellen and Abubakar, 2021), were hit particularly hard by the prolonged drought resulting from this El Niño. Creedy et al.'s (2022) 70-year analysis demonstrates that cocoa production is significantly negatively affected by El Niño events. The 2015–16 El Niño was one of the strongest tropical climate events in a century (Rifai et al., 2019), resulting in prolonged drought, low air humidity, high evapotranspiration, and high maximum daily temperatures over West Africa which dampened global cocoa supply (Abdulai et al., 2018; ICCO, 2016). Drought is cocoa growth's most critical abiotic threat (Gateau-Rey et al., 2018; Seutra Kaba et al., 2021). Irrigating cocoa is rare in Ghana, where poorly-resourced smallholders are impeded by various social, technical, and economic challenges (Agbenyo et al., 2022; Bunn et al., 2019). It is likely that <0.5 % of Ghanaian cocoa is irrigated (Carr and Lockwood, 2011). Furthermore, as many Ghanaian cocoa smallholders lack an adequate array of viable income alternatives (Asante et al., 2017), regular rainfall and strong cocoa harvests are necessary (albeit insufficient) to sustain their livelihoods.

The climate threat facing Ghanaian cocoa cultivation is well known, as evinced by chocolate industry initiatives to make cocoa cultivation more 'resilient' by securing supplies, e.g., sustainable cocoa, yield intensification, and climate-smart cocoa (Camargo et al., 2019; Carodenuto, 2019; Kalischek et al., 2023). However, as Nasser et al. (2020), Maguire-Rajpaul et al. (2022), LeBaron (2021), Krauss (2018, 2016), and Odijie (2019, 2018, 2016) highlight, such buyer-driven interventions may perpetuate poverty, entrench inequalities, and exploit cocoa labourers when they fail to foreground cocoa smallholders' livelihood concerns.

As well as understanding the mounting threat climate change poses, it is imperative to understand how people growing cocoa withstand climate shocks to sustain their livelihoods at different timepoints and how the multiple dimensions of poverty they experience intersect with their resilience. Multidimensional assessments of poverty understand poverty beyond monetary deprivations by incorporating dimensions such as health, food security, living standards, education, infrastructure (Alkire, 2002; Alkire and Santos, 2014; Nguyen et al., 2021). Buyer-centric resilience initiatives to guarantee agricultural supplies regularly overlook underlying poverty conditions and causal economic-development challenges (Barrientos, 2012; Crane et al., 2019; Grabs, 2017; Odijie, 2018). Poverty alleviation and resilience policies centred on monetary improvement by intensifying cash crops (such as cocoa) can reinforce labour exploitation when they disregard subsistence crops, worsen food insecurity and potentially other dimensions of existing poverty (LeBaron and Gore, 2020; Michler and Josephson, 2017).

This paper politicises climate resilience by fusing it to multiple dimensions of poverty and lived experiences of drought by rain-dependent cocoa smallholders. Our contributions to the literature and policy of resilience include: exploring the merits of embedding poverty within resilience and proposing that both poverty and resilience be treated multidimensionally. Using a longitudinal dataset from before, during, and one year after the 2015–16 El Niño-induced drought, we ask: 'how do different dimensions of poverty shape smallholders' climate resilience?'. With cocoa smallholders, we co-identified different forms of resilience pertinent to their lives – i) meeting basic household needs, ii) carrying out adaptation, and iii) preparedness for future droughts – and analysed how these different forms or "outcomes" of resilience interact with different poverty dimensions. Drawing on three years of surveys (supplemented by focus group discussions and interviews), our dataset assembles climate shock observations made by cocoa-growing households on their responses and adaptive actions to drought. There has been little attention on this important resilience-poverty nexus and, to our knowledge, no work to date engaging longitudinal empirical data spanning a climate shock.

Heeding several IPCC Reports' calls to incorporate the needs of the poor into climate-resilient interventions (IPCC, 2022), this paper focuses on cocoa smallholders' pre-drought economic development challenges and underlying poverty conditions by fusing the multidimensional nature of poverty (Alkire, 2007, 2002) to resilience. An improved understanding of the intertwined dimensions, drivers, and outcomes of poverty and resilience – along with inclusionary governance for equitable resilience (Ensor et al., 2021; Matin et al., 2018) – are critical for upholding the SDGs' central promise to 'leave no one behind' (Schipper et al., 2020).

2. Theoretical foundations

2.1. Resilience – Growth and contestation

Resilience broadly refers to a capacity for dealing with change and shock (Lindow et al., 2020). Like sustainability and adaptation, the concept of resilience is appealing because it: is widely understood; is often extolled as universally desirable; and cuts across scientific

disciplines and sectorally-divided donor institutions (Béné et al., 2012; Fünfgeld and McEvoy, 2012). Although resilience thinking originates in engineering and ecology, the concept became extensively used to explain how social-ecological systems (SESs) resist climate-related stressors or undergo change. Walker et al.'s influential definition states that resilience is the capacity of SESs "to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks" (2004: p.1).

Etymologically and in terms of its engineering definition, resilience refers to bouncing back to a previous steady state. Holling (1973) attested that equilibrium-based approaches were inadequate for explaining ecosystems against anthropogenic disruptions (Cavanagh, 2017). For ecological behaviour, Holling delineated between i) *resilience* as "the ability […] to absorb changes […] and still persist," versus ii) *stability* as "the ability […] to return to *an* equilibrium state after a temporary disturbance" (1973: 17–18), thereby introducing the existence of *numerous* stable states (Holling, 1986).

Other strands of resilience thinking refer to adaptive capacity, transformability, and learning for future shocks (Folke, 2006). Evidently, resilience can refer to many qualities within a system. This necessitates both a multi-dimensional approach to studying resilience, but also a politically engaged approach since resilience involves profound questions concerning how power shapes processes and priorities in pursuing resilience (Bahadur and Tanner, 2014; Quandt and Paderes, 2023).

Davoudi et al. (2012), Weichselgartner and Kelman (2015) warn of important issues to consider when transposing resilience from ecological description to social prescription: how political dimensions are expunged (Mikulewicz and Taylor, 2020), or how many SES approaches fail to capture underlying poverty and inequalities (Wachsmuth, 2015). An issue oft-neglected in development policy is that Holling defined resilience and disequilibrium to *describe* (1986, 1973) the "paradigms of ecological function" (Holling, 1987), rather than *prescribe* "how coupled SES *should* behave" (Brand and Jax, 2007; Brown, 2016; Cavanagh, 2017: 114). Resilience's systems approach does not equally engage social and ecological aspects, with Mikulewicz (2019) cautioning that "resilience should not be considered a human-centred approach to development" (p.277). Nevertheless, "resilience is everywhere in contemporary debates about global environmental change," (Brown, 2014: 107) where it is used normatively as a desirable state.

This paper acknowledges the contestations surrounding resilience as a term, goal, or even the preferred outcome (Cote and Nightingale, 2012). Unlike many international development agencies, we do not accept resilience as an "unalloyed good for promoting sustainable development" (Mikulewicz, 2019: 290). Resilience's reductivist nature has been met by abundant critical backlash (Béné et al., 2016; Jennings, 2011; Taylor, 2014). There are myriad limitations to resilience-based approaches: often against what is excluded from resilience measures (e.g., underlying vulnerability drivers, chronic poverty, structural poverty, recovery over time, enacting adaptive strategies, future preparedness), or the ways in which top-down objective measures of livelihood resilience by external 'experts' exclude context-specific indicators of resilience (Quandt, 2018: p.254). To address some of these criticisms, this paper pluralises what resilience can mean by integrating smallholders' perspectives and other subjective measures of resilience gained through participatory methods (Clare et al., 2017; Jones, 2019; Quandt and Paderes, 2023). With cocoa smallholders' input, we co-defined distinct 'dimensions' or 'outcomes' of resilience pertinent to how they cultivate cocoa and sustain their household livelihoods (cf. sections 3.2 and 3.4).

Cote and Nightingale (2012) critique SES approaches to resilience thinking as "inadequate […] because it repeats the weaknesses of earlier approaches in risk and hazard science that overemphasized the role of physical shocks and undertheorized that of political economic factors in conceptualizing vulnerability" (p.478). Accordingly, resilience is lambasted for focussing on climate events, thereby side-lining non-climatic, social, and political-economy causes of crises (Rao et al., 2020; Schipper et al., 2020; Singh et al., 2021, Singh et al., 2016), as well as being constrained by ecological assumptions and/or single equilibrium assumptions wholly inapplicable to human communities (Cretney, 2014; Wachsmuth, 2015). Others rail against how pursuing resilience upholds neoliberal, capitalist pathways that fuel climate change, perpetuate unequal resource distribution (Barnett, 2020; Nagoda, 2015), while stifling the potential for radical transformation (Carr, 2019; Manyena et al., 2019; McKeown et al., 2022).

Furthermore, prevailing conditions in high-poverty, low-income communities mean many households are insufficiently resourced for meeting basic needs, much less for accumulating resources to adapt to – and prepare for – climate shocks (Bailey, 2017; Sen, 1999; Thiede, 2016). When resilience theory and policy focus primarily on climate change and climate shock events as the primary cause of crises, myriad social, political, and economic causes are silenced (Kashwan and Ribot, 2021; Ribot, 2022). Despite extensive critique and empirical data against interventions aiming to bolster resilience in isolation, without considering social issues, poverty's causal foundations, or the lived experiences of Global South communities, myopic 'techno-fix' approaches pervade development programmes (Béné et al., 2011; Boyd, 2017; O'Brien and Selboe, 2015).

2.2. *Fusing resilience to multiple dimensions of poverty*

To counter techno-fix reductivism (Nightingale et al., 2020; Rasmussen, 2018) and generate more human-centred framings of resilience (Mikulewicz, 2019), this paper's pluralistic approach examines multiple dimensions of poverty in tandem with resilience and thereby accords with livelihood resilience which is centred on the capacity of people to sustain their livelihood opportunities and well-being despite disturbances (Tanner et al., 2015: p.23). We deem poverty as a dynamic process, transformable by shocks such as droughts, harvest losses, etc. Following Sen (1985, 1976), Bourguignon and Chakravarty (2002, 1999), and particularly Alkire and Foster (2011, 2007), we deem poverty to be a pluralised, multi-dimensional experience and recognise that low income people may also suffer insufficient levels of other well-being attributes, e.g., literacy, numeracy, health care, living standards.

We draw on Alkire-Foster's multi-dimensional poverty index (MPI) approach which broadens uni-dimensional monetary measures of poverty to incorporate other dimensions of poverty and welfare (Alkire, 2007, 2002; Alkire et al., 2017). Education, health, and living standards are three core poverty dimensions which recur across many studies (Alkire and Santos, 2010; Alkire and Seth, 2015; Saboor et al., 2015) to which other context-dependent dimensions and indicators of poverty – including income – are included (Bérenger and Verdier-Chouchane, 2007; Calvo, 2008). All can be readily adjusted to incorporate alternative poverty dimensions, indicators, cut-offs, and weights (Santos and Alkire, 2011, p.1). Alkire-Foster's MPI has made a significant, lasting impact on poverty measurement. Several national governments use MPI measures that rely on Alkire–Foster's methodology; yet within agri-development policy, income still dominates target setting.

Typically, multiple dimensions of poverty – including income, education, social exclusion, assets, and infrastructure – influences people's vulnerabilities (Casale et al., 2010; Eakin et al., 2012; O'Brien and Barnett, 2013; Wisner et al., 2004). Nevertheless, poverty, adaptation, and resilience interventions in agri-development in general – and cocoa specifically – have focussed on narrowing yield gaps by intensifying production. This includes many corporate sustainable intensification efforts to directly boost cash crop income, such as cocoa's newly implemented living income differential. This is problematic because many issues relevant to what constitutes poverty are overlooked. A singular focus on export crop productivity *neglects*: (i) diversifying farmers' income streams (Thompson et al., 2022); (ii) addressing poverty's root causes and social differentiation e.g., gender dynamics (Asaaga, 2021; Busquet et al., 2021; Quisumbing and Pandolfelli, 2010);

(iii) problematising agricultural and economic growth (Mikulewicz and Taylor, 2020); and (iv) alleviating non-income dimensions of poverty such as wider food security (Kumeh et al., 2022).

Poverty alleviation and resilience policies concentrated on intensifying cash crops risk disregard subsistence crops for securing food and household resilience, potentially exacerbating existing poverty (Michler and Josephson, 2017). For example, even if a farmer harvested a large volume of cash crop, they may nevertheless suffer food insecurity if subsistence crop yields were poor. Similarly, limited infrastructure may impede access to healthcare, agronomic information, education, or banking services, regardless of export-crop income. Therefore, this paper draws on theories of multiple dimensions of poverty (Alkire, 2007; Atkinson, 2019; Cohen, 2010; Thiry et al., 2018) to examine simultaneous deprivations.

While resilience has been linked theoretically to vulnerability – which is itself linked to poverty – by various scholars (e.g., Adger, 2006; Akter and Mallick, 2013; Maru et al., 2014; Miller et al., 2010; Nyantakyi-Frimpong and Bezner-Kerr, 2015), overall such work has tended to be conceptual rather than empirical. Despite resilience's and poverty's interconnections, explicit linking of poverty to resilience is rarer (Barrett and Constas, 2014; Lade et al., 2017); even rarer are situated analyses of tangible, complex social issues faced by communities striving for resilience. Notable exceptions include: Béné et al.'s (2011) evaluation of resilience's usefulness among Nigerian small-scale fishers; Forsyth's (2018) identification of socially-inclusive resilience pathways in Myanmar; Hirons et al.'s (2018) demonstration of how livelihood practices among Ghanaian smallholders can enhance or undermine resilience; and Mikulewicz's (2019) grounded critique of 'dehumanised' resilience interventions in São Tomé and Príncipe. Forging empirical connections between resilience and experiences of poverty is imperative given accelerating climate breakdown along with persistent poverty, particularly in rural SSA. We do this by drawing on longitudinal data surrounding a climate shock of a drought to examine how poverty dynamics are immediately impacted by drought, and the ways in which experiences of poverty are counterbalanced by household capabilities, including adaptation, recovery, and preparedness, or all that is broadly termed resilience.

Akin to livelihood resilience which intends to minimise harm and loss by bringing people's lives to the fore and commands attention on societal root causes (Quandt, 2018; Tanner et al., 2015), our people-centred approach does not limit resilience to withstanding only climatic phenomena, but examines poverty dimensions before the climate shock to examine their role in enabling coping, adapting, and preparedness. Our foundational premise is that resilience-building interventions that neglect poverty could lead to outcomes that exacerbate vulnerabilities and poverty, and possibly even maladaptive outcomes (Asare-Nuamah et al., 2021; Eriksen et al., 2021; Schipper, 2020). Thus, this paper examines poverty and resilience's interactions, and treats both concepts as multi-dimensional phenomena.

Given resilience's polysemic nature (cf. Brand and Jax, 2007; Manyena et al., 2019), we do not produce a single resilience measurement; indeed, Weichselgartner & Kelman (2015) highlight the need to look beyond quantitative streamlining of resilience into one index. Instead – and analogous with recognition that poverty is a multi-dimensional phenomenon – we acknowledge that multiple types of resilient states exist (Holling, 1986), and that these are highly *context-dependent.* Thus we identify with smallholder input distinct, subjective "resilient outcomes" (Jones and d'Errico, 2019; Jones and Tanner, 2017): e.g., cocoa smallholders' ability to meet basic household needs during or after a drought, or their preparedness for future climate shocks. We regard each of resilient outcomes as specific realisations of the broader concept of resilience. Indeed, the malleable concept of resilience has been surmised as "too vague and frequently too poorly understood by those who offer to deliver it to local people" (Mikulewicz, 2019: 276). Such appraisals motivated us to incorporate smallholders' perspectives and experiences, elucidated in our methodology to which we now turn.

3. Methodology

3.1. Study sites

We draw on a unique longitudinal dataset collected across three years (before, during, and after the 2015–16 El Niño-induced drought) in six cocoa-growing villages in Assin South district of Ghana's Central Region (see Fig 1). This study formed part of a socio-ecological consortium which/that explored ecosystem limits to poverty alleviation in forest-agriculture landscapes. The studied landscape is dominated by the 375 km2 Kakum National Park (gazetted since 1992), which is surrounded principally by <5 ha smallholdings growing cocoa, oil palm, and subsistence crops (Hirons et al., 2018; Moore et al., 2019). The locations of the villages and nearby plots were chosen to assess the influences of intact forest and shade management on ecosystem services and their impacts on cocoa yield. Ecological and meteorological plots were stratified by distance from forest edge. That consortium had, since 2013, forged strong relationships with these six cocoa-growing villages, so we were welcomed to return to conduct surveys in three consecutive years. While our study focused on one district in Ghana, climate shocks have broadly similar biophysical impacts across the tropical south of Ghana and Côte d'Ivoire where rain-dependent smallholders grow >60

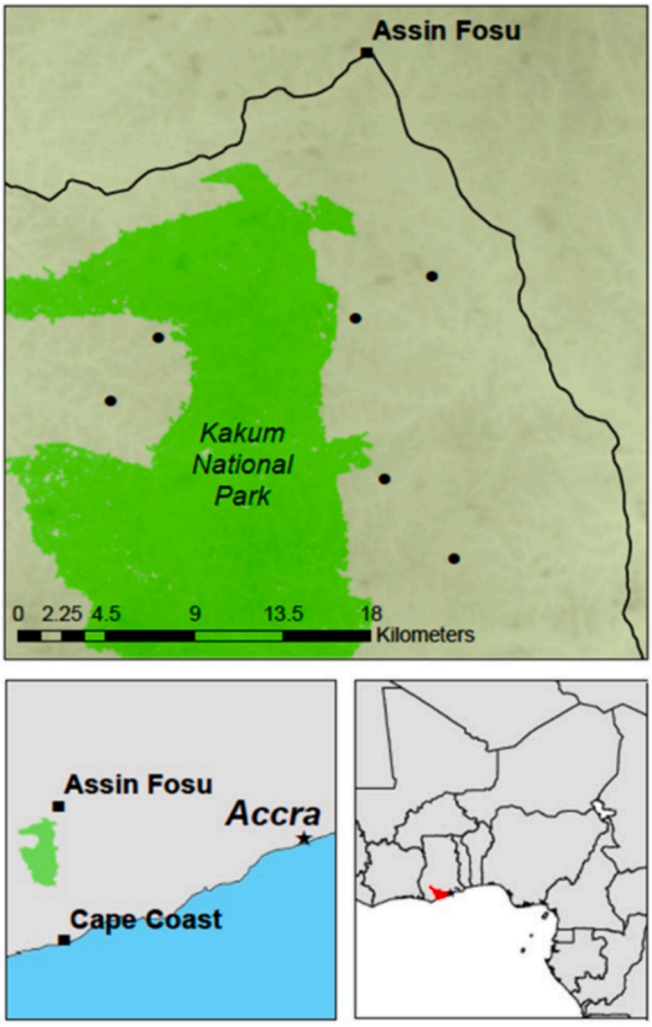

Fig. 1. Map showing study sites. Circles represent approximate location of studied villages. Squares represent major settlements and the black star denotes Ghana's capital cities of Accra.

% of the world's cocoa (Bunn et al., 2019; Läderach et al., 2013).[1]

Cocoa ideally requires regular rainfall of 1,500–2,500 mm annually (Ross, 2014), but can grow under 1,300–2,800 mm annual precipitation (Carr and Lockwood, 2011). Ghana's Central Region's annual average rainfall of 1380 mm is at cocoa's lower threshold (Whitfield et al., 2019). Ghana's 2015–16 cocoa harvest was reduced by the prolonged El Niño-induced drought (Abdulai et al., 2018; ICCO, 2016; Maguire-Rajpaul et al., 2020). Elevated temperatures intensified water vapor deficits and lowered soil moisture (Morel et al., 2019). These hydro-climatic conditions were comparable to climate change projections for the next few decades (Schroth et al., 2016). Instead of speculating how smallholders might respond to possible future extreme weather or ask them to recall responses to historical shocks, we could focus on smallholder experiences of that recent drought.

3.2. Co-producing knowledge via scoping interviews and focus group discussions

Many empirical resilience approaches solicit little (if any) judgement from the subjects in question (Ensor et al., 2021; Jones, 2019). The norm for measuring both poverty and resilience has been via pre-defined variables (e.g., Armitage et al., 2012; Bebbington, 1999; Chantarat and Barrett, 2012; Scoones, 2015, 2009) external 'experts' according to framings of 'objectivity' (Jones, 2019; Jones and d'Errico, 2019; Jones and Tanner, 2017; Quandt et al., 2019) which results in their values forming the inquiry, rather than those who intimately understand their own capacities, limits, and poverty experiences (Bahadur et al., 2015; Carpenter et al., 2001). Accordingly, participatory approaches assessing resilience and poverty through subjects' experiential expertise are increasingly advocated (Beebeejaun et al., 2015; Béné et al., 2016; Bennett and Roberts, 2004; Clare et al., 2017; Collins and Evans, 2002). Our epistemological foundation was first to listen to what constitutes poverty locally and to smallholders' self-assessments of how they fared managing their households and farms (i.e., their 'resilience') before, during, and after the El Niño-induced drought.

We held 12 gender-segregated FGDs in 2015, four in July 2016, and six in April 2017. To minimise gender-based bias in our data, we hosted separate FGDs for men and women as access to resources can be heavily gendered (Barrientos, 2013; Friedman et al., 2018) as can perspectives about resilience among smallholders (Quandt, 2019). Within many SSA agricultural communities, positionalities and power dichotomies are discernible between genders meaning that some might feel uneasy discussing their thoughts in front of other people and some voices might dominate over others (Bourey et al., 2012; Caretta and Vacchelli, 2015). The FGDs and interviews were conducted in Twi and live interpreted into English and recorded through detailed note-taking. These data were then thematically coded Fereday and Muir-Cochrane (2006) to draw out insights into respondents' perspectives on poverty and resilience, and these findings were then used to inform the development of the household survey questions. From these smallholder accounts, our surveys and analyses considered the following nine dimensions when estimating poverty in this cocoa smallholder social-ecological system: income, health, education, basic needs, assets, land assets, food security, empowerment, and social connectedness. Each of the nine dimensions consists of between two and six indicators. To provide a degree of standardisation and comparability, the nine poverty dimensions and 38 indicators for poverty (presented in Table 4.2) combine the literature (e.g., Alkire-Foster's multi-dimensional poverty index (2011) and Hirons et al., 2018) with smallholder accounts from interviews and FGDs. As well as informing the survey design, we use the qualitative data primarily to supplement, illustrate, and enrich the quantitative findings which form the core focus of the analysis presented here.

Following the drought, further interviews and FGDs in 2016 and 2017 were used to refine household surveys in those years (adding questions on drought impacts and adaptation). Our 'experiential expertise' subjective resilience (Jones and Tanner, 2017; Quandt and Paderes, 2023) approach engaged smallholders as stakeholders who co-produced knowledge (Beebeejaun et al., 2015; Wachsmuth, 2015). In interviews and FGDs, smallholders related practical challenges they encountered and situated the drought within their broader social contexts.

3.3. Household surveys

Semi-structured scoping interviews and FGDs elicited rich, highly-localised repertoires which we used to inform the design of survey questions to quantitatively assess distributions of such experiences. In recognition of the centrality of a household in managing shocks (Frankenberger and McCaston, 1998; Toole et al., 2016), our surveys' unit of analysis was households rather than individuals which enabled more community members' experiences to be captured. We surveyed representatives from 108 households (randomly sampled from household lists, stratified by gender of household head) in 2015; 107 in 2016; and 103 in 2017. We gave a verbal preamble that the survey questions would refer to all household members and to decisions made on behalf of the whole household. We acknowledge that surveying the person who makes most of the decisions for a group to answer on behalf of all its members is unlikely to be perfectly representative. However, we designed our research according to locally recognised social units (Newing et al., 2024) (i.e., households) and according to local customs. From our long-standing relationships in these cocoa-growing villages, we deduced that respecting hierarchies by approaching the heads of each household was most culturally appropriate.

Since surveying one member of a household risks overlooking intrahousehold power dynamics (e.g., women being excluded from decision-making processes over land, farming (Friedman et al., 2018), and spending (Barrientos, 2013)), we set out to lessen biases against women, widows, and younger cocoa farmers by conducting focus groups with representatives from these socio-demographic groups, and later creating survey questions based on their insights. We further attempted to minimise bias by inviting additional household members to attend surveys should they wish.

In a few cases, we were unable to match a household from 2015 to details given by respondents in 2016 or 2017 – likely because a household representative was unavailable for survey in a later year. In total, 95 households matched across all three years with at least 10 household representatives surveyed per village. The sample size represents a compromise between depth and richness of survey data needed to sufficiently garner responses across the multiple dimensions of poverty and resilience we are examining and resources available.

We acknowledge the authors' positionality and extrinsic roles (several are foreign nationals) as distinct from Ghanaian partners, enumerators, and surveyed households. Enumerators and interpreters provided essential bridges between the research and cocoa-growing communities. All data (interviews, FGDs, and surveys) were gathered in Twi. All questions posed had already been translated and piloted into formats readily understandable by cocoa smallholders' linguistic and cultural experiences.

3.4. Survey data processing and analysis

To examine poverty and resilience's relationships, we treated each poverty dimension/indicator from 2015 (the pre-drought year) as a single independent variable. As resilience is fraught by "definitional ambiguities" (Jones, 2019: 5), and no consensus exists on measuring

[1] Such an extreme geographical concentration of cocoa production makes the global industry highly vulnerable to a regional decline in climatic suitability (Schroth et al., 2016). Cocoa's dependence on regular rainfall, teamed with low irrigation possibilities, makes smallholders especially susceptible to the impacts of climate variability and change.

resilience (Béné, 2020; Schipper and Langston, 2015), rather than reducing the totality of resilience into a single quantitative index, we constructed composite measurements of distinct, contextually-relevant types of resilience, hereafter referred to as "resilient outcomes". Following smallholder input, we co-identified resilient outcomes of i) meeting basic household needs, ii) adapting to drought, and iii) being prepared for future droughts. We acknowledge these are not the only outcomes that may be relevant to resilience; rather these are subjective resilience measures that were deemed pertinent by smallholders themselves. "What resilience means within development practice will have important consequences both for development practitioners and the communities in which they work" (Walsh-Dilley et al., 2016: p1). Resilience meaning a household covering their basic needs is essential to many in economically-developing communities, and applying such a "human-centred" subjective approach to resilience (Chandler, 2013; Cutter, 2016) addresses one recurrent critique of the "power-blind" resilience concept (Davoudi et al., 2012).

Three resilient outcomes identified with smallholders were:

- *Ability to meet critical needs*. Each year, households reported whether they could meet six different basic needs (e.g., obtaining enough food; being able to afford medicine) widely identified by smallholders as being critical and fundamental to coping. We computed a critical needs score for each household in 2015, 2016, and 2017 which ranged from 0 (no critical needs met) to 6 (all critical needs met).
- *Drought adaptation*. The "drought adaptation" score was computed from Likert-scale responses to five prompts (asked in either 2016 or 2017) concerning drought adaptation, and specific adaptive changes implemented (e.g., increasing food crop storage, finding wetland area to farm). A single score was computed per household.
- *Preparedness for future droughts*. Analogous to the previous resilient outcome, preparedness was computed from Likert-scale responses to five prompts (asked in either 2016 or 2017) concerning *future* droughts, and adaptive strategies households *planned* to implement in future (e.g., "will change farming approach following drought experienced", "now know how to cope with drought conditions", "future droughts' impacts on me would be similar or less"). Here too a single score was computed per household.

We computed summary statistics on the distribution of scores associated with each of these resilient outcomes. Our main quantitative analysis examined statistical associations – if any – between each resilient outcome and each of the 38 indicators of poverty (listed in Table 4.2) across all nine dimensions considered.[2] The only exception was food security, which we excluded from comparison with the critical-needs resilient outcome, since the same two survey questions that probed food security in 2015 were used to compute the critical needs score in that year; thus this poverty dimension was correlated with the resilient outcome *a priori*.[3]

Statistical tests of association performed depended on the type of variable associated with each poverty indicator, i.e.: Spearman rank correlation tests for quantitative poverty indicators, or categorical indicators spanning many (e.g., 10) categories and where the latter could be mapped to an equally-spaced linear interval; Kruskal-Wallis *H*-tests (one-way analysis of variance) for categorical poverty indicators spanning three or more categories; or Mann-Whitney-Wilcoxon *U*-tests for binary categorical variables. Apart from being appropriate for the respective variable types, these tests were chosen as they are all non-parametric, i.e., "distribution-free", and do not assume e.g., normally-distributed variables. In what follows, we report only statistical associations between poverty indicators and resilient outcomes that were statistically significant at $p < 0.05$ or $p < 0.10$ (the latter in parenthesis) levels. Survey data were analysed using the Python scipy.stats library.

Table 4.1
Summary of sociodemographic demographic characteristics of the 95 household representatives who completed our survey in all three years. Here and hereafter, we use the shorthand notation μ, m, and sd to represent mean, median, and standard deviation, respectively.

Demographic variable	Distribution of responses (2015)
Respondent gender	Male: 62 %; female: 38 %
Respondent age (years)	μ = 46.9, M=48.0, SD=13.8 (range: 18–91)
No. children (<18 years) in household	μ = 4.8, M=4.0, SD=3.8 (range: 0–19)
No. adult males in household (excl. respondent)	μ = 1.6, M=1, SD=1.8 (range: 0–10)
No. adult females in household (excl. respondent)	μ = 1.4, M=1, SD=1.7 (range: 0–8)
Time respondent has been in village (years)	μ = 29.1, M=30, SD=13.7 (range: 2–66)
Age (average) of cocoa farm (years)	μ = 18.1, M=15.0, SD=11.4 (range: 0–46)
Respondent's migrant status	Local: 40 %; immigrant: 60 %

4. Results and discussion

See Table 4.1.

4.1. Pre-drought sociodemographic characteristics

Since the impacts of any climate hazard are socially stratified by pre-existing vulnerabilities (De Juan et al., 2020; Ensor et al., 2021), it is imperative to examine poverty conditions before the drought struck. In 2015, the mean household annual cocoa-derived income was 7390 Ghanaian cedis (US $1989), while the mean annual income from all other sources was 2413 cedis (US $650). This translates to US $0.95 per person per day: half the World Bank's international poverty line of $1.90 per person per day.[4] Similarly, LeBaron's (2021) surveys in 74 Ghanaian cocoa communities found farmers were only earning around 30 % of the poverty line. Such material poverty among Ghana's cocoa farmers is widely reported in the literature (Asamoah et al., 2013; van Vliet et al., 2021; Waarts et al., 2019). Combining credible datasets from Kongor et al. (2018), Akrofi-Atitianti et al. (2018), Ingram et al. (2018), and Asare et al. (2019), Boeckx et al. (2020) calculated that the proportion of Ghanaian cocoa households achieving a 'living income' from cocoa production is as few as 5 %. Likewise, Fountain and Hütz-Adams (2020) concluded that very few West African cocoa farmers earn a living income. Although obtaining accurate and reliable figures is difficult, widespread monetary deprivation among cocoa farmers exists independently of droughts or other climate shocks. Therefore, initiatives claiming to boost farmer resilience by increasing yields are unlikely to serve cocoa households meaningfully; leading some commentators to equate increasing yields to exerting more labour for exploitatively low earnings, and judging this as unjust (Amuzu et al., 2022; Nasser et al., 2020) and tantamount to continuing colonial capitalism (Bernards,

[2] We experimented with combining all indicators in each dimension to produce a "master proxies" for all dimensions. However, apart from a great degree of arbitrariness in how the different indicators were weighted within dimensions, we also found that this approach did not change overall conclusions about which poverty dimensions were associated with which resilient outcomes.

[3] While such an issue could be avoided with longer-term and more predictable funding streams for longitudinal research that permits temporal considerations to be embedded into survey design. Furthermore, this illustrates the potential for tautological analyses and the challenge in unambiguously disentangling poverty from resilience.

[4] The World Bank's international poverty line was set at $1.90 per person per day from 2011 until September 2022.

2021; Collins et al., 2021; Odijie, 2019).

Pre-drought, more than a third of surveyed households failed to secure basic food needs and the mean spend on food was 46 % of income. Only 52 % households believed they had enough savings to cope and feed themselves in a low-cocoa-yield year or recurrent cocoa "lean" seasons, and focus group discussants recounted debt bondage with interest rates as high as 100 %, corroborating what LeBaron's (2021) Ghanaian cocoa farmer surveys found. A focus group quote emblematic of this plight was that *"[food] can run out during a lean season and you must buy food and you don't have money either in lean seasons*". The high proportion of income spent on food may be due to several conflating factors e.g., i) only 12 % of households having access to a refrigerator, impeding safe food storage – a concern repeated across focus groups; ii) relatively few households owning *any* means of transportation – smallholders recounted how this, combined with unreliable rural taxis, meant that reaching markets to buy and sell food was challenging; combined with iii) the aforementioned prevalent failure to secure a living income;

The typical household dedicated twice as much of their land to cultivating cocoa – a crop exported for consumption as a luxury food abroad – than all other crops combined (see Table 4.2 and Supplementary Material) [Table 4.2 here in the colours used as each colour corresponds to one poverty dimension and repeats across tables]. More than a third of households failed to secure basic food needs. Prevalent food insecurity among Ghanaian cocoa farmers is extensively reported in the literature (Asamoah et al., 2013; Dei Antwi et al., 2018; Hashmiu et al., 2022; Kumeh et al., 2022; Maguire-Rajpaul et al., 2020). Evidence of cocoa's expansion into multiuse croplands across Ghanaian cocoa-producing landscapes is concerning (Ajagun et al., 2022; Asubonteng et al., 2018; Wessel and Quist-Wessel, 2015) since conversion of food-crop lands into cash-crop landscapes often worsens local food security and reduces welfare (Adjei et al., 2020; Bymolt et al., 2018; Tankari, 2017).

70 % of households reported frequently suffering poor health before the drought, while 18 % had experienced under-five mortality; for comparison, SDG Target 3.2 aims for under-five mortality rates lower than 2.5 % of live births. More than half of surveyed households either lacked any access to clean drinking water or had only shared access (9 % and 42 %, respectively). Nevertheless, the majority of studies on poor health among cocoa farmers tend to neglect such fundamental health issues and instead focus on personal protective equipment against hazardous agro-chemicals (Fosu-Mensah et al., 2016; Okoffo et al., 2016), advocating eye protection (Boadi-Kusi et al., 2017; Boadi-Kusi et al., 2016). Access to potable water, doctors, medicines etc. and improving farmers' health are lacking in interventions, with corporations prioritising securing cocoa supplies, and the state (via Cocobod) prioritising agronomic extension and agro-input provision. Yet as one focus group who unanimously agreed on the importance of health put it: when a cocoa farmer *"is strong and healthy they can farm and you can get whatever you want, but those who are sick or disabled will be poor"*.

Table 4.2 summarises our nine dimensions of poverty, the indicators (at least two) for each dimension, and the distribution of responses across all 95 households before the drought. Even under favourable climatic conditions, the surveyed cocoa smallholders suffered material poverty, structural poverty, poor access to public services, food insecurity, and failed to meet basic needs. Such multiple dimensional poverty is ubiquitous among West African cocoa smallholders, and has prompted examinations into the global cocoa value chain's power asymmetries as well as the marginalisation, relative vulnerability, and even exploitation of smallholder labourers (Barrientos, 2014; Krauss and Krishnan, 2022; LeBaron and Gore, 2020; Odijie, 2018). Yet buyer-driven governance overlooks already existing poverties and narrowly equates resilience as guaranteeing cocoa supplies without further deforestation reputational risk (Grabs, 2017; LeBaron, 2021).

The effect of drought is instantaneously negative on cocoa production (Creedy et al., 2022). Indeed, half of surveyed households reported 2016 cocoa harvests up to 50 % less than pre-drought, and a further quarter reported losing up to 66 % of their cocoa compared to pre-drought. Given that before the drought hit, the average household was already earning only half of the World Bank's international poverty line, and that adverse climate conditions are predicted to increase in frequency and severity in coming decades (Afriyie-Kraft et al., 2020a; Agbongiarhuoyi et al., 2013; Ibn Musah et al., 2018; Schroth et al., 2017), Ghanaian cocoa smallholders are at risk of suffering deepening poverty. Only 22 % of households reported a harvest around the same size or better in 2016 than 2015 (this included two households who had only recently started growing cocoa and had zero yield in 2015 only). In 2017, however, 80 % of households reported cocoa harvests comparable to or larger than 2015′s, indicating broad recovery of the cocoa crop. Such a recovery resonates with Creedy et al.'s (2022) 70-year analysis which also provides evidence that climate change is altering how the cocoa crop responds to climate shocks.

The drought impacted wider food security in 2016. When asked about the impacts of reduced and/or delayed cocoa harvests in 2016, 65 % of all N=95 households reported eating less food than usual. FGDs related that it was commonplace for adults to reduce food intake to just once per day and *"sacrifice their second food for their children"*. In the face of high dependency on agriculture, droughts might not only directly lead to lower cash crop income and depressed supplies of food and basic nutrients from subsistence agriculture, but droughts can shock the landscape's entire food system lowering households' ability to secure sufficient nutritional intake (Lohmann and Lechtenfeld, 2015). Focus groups discussants lamented the difficulty buying foods at local markets and how low supplies resulted in high prices during the drought and its aftermath. Of the households that grew the subsistence crops maize, tomatoes, cassava, or plantain (N=86, N=86, N=67, N=60, respectively), more than 50 % reported harvests up to two thirds *smaller* in 2016 than in 2015.

Oil palm was an exception: 75 % of the N=52 households cultivating oil palm reported no change in 2016′s harvest compared to 2015. The latter result suggests oil palm could be resilient against drought and higher temperatures at least initially, which is consistent with findings from Ruf (2015), Odijie (2018), and Khatun et al. (2020); and/or that sustained oil palm yields could be due to changes in how farmers managed their oil palm trees during the drought (Fleiss et al., 2022). Whatever the factor driving sustained yields through the drought, the studied smallholders deem oil palm to be an attractive crop because it smooths household income throughout the year as it yields continuously. Households reported harvesting oil palm kernels "every fortnight". Surveys found that oil palm cultivation area was very significant for meeting critical needs in 2015 (p = 0.01). Farmers in these landscapes have historically diversified into oil palm (*Elaeis guineensis*) which is native to these Upper Guinean tropical forests and its many products are traditionally used in local cuisine (Khatun et al., 2020). However, commodity-centric governance (Bastos Lima and Persson, 2020; Zu Ermgassen et al., 2022) promotes defying such signals and the need to diversify (Odijie, 2019). Our findings and these observations suggest that resilience interventions which support agricultural diversification

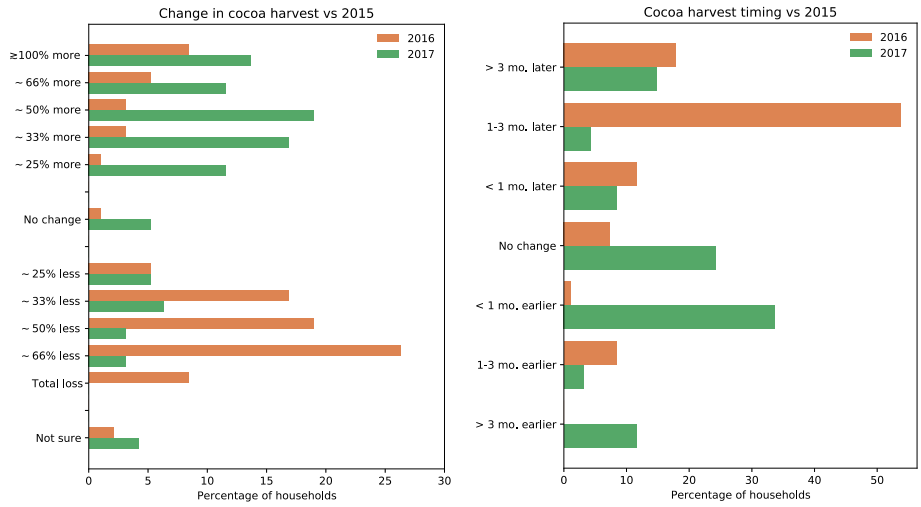

Fig. 4.2. Reported changes in cocoa harvests (left panel) and changes in harvest timing (right panel) in 2016 and 2017, in both cases compared to the pre-drought year, 2015. The changes are grouped into categories identical to those used in survey questions.

away from only cocoa could increase the system's ability to absorb shocks and thereby alleviate poverty. But agricultural diversification is not of concern to cocoa corporations who equate resilience with securing cocoa supplies.

The right panel in Fig. 4.2 [Figure 4.2 here in colours of publisher's choice] shows the reported change in the *timing* of the cocoa harvest in 2016 and 2017 compared to pre-drought. *When* rains arrive matters for agriculture and agricultural livelihoods (Stringer et al., 2021). In 2016, 83 % of households reported later-than-usual cocoa harvests, with 71 % reporting harvests delayed by at least one month. Decreases and/or delays in cocoa harvests can lead to severe difficulties for households since Ghanaian smallholders depend on cocoa harvests for 60–100 % of their household income (McKinley et al., 2014; Tsiboe et al., 2016). Within our surveyed sample, cocoa contributed ~ 75 % of household income before the drought (Table 4.2). Across Ghana, many cocoa smallholders lack adequate savings (Asamoah et al., 2015; LeBaron, 2021; Peprah, 2015), banking facilities (Löwe, 2017; Unnikrishnan et al., 2022), or insurance (Afriyie-Kraft et al., 2020b; Agbenyo et al., 2022); in our sample pre-drought, only 52 % reported inadequate savings to cope with low cocoa-yield years (Table 4.2). Drought-induced cocoa harvest reductions and delays thus compromised household cashflow and food intake, both of which significantly influenced ability to manage household critical needs (section 4.3.1), adoption of adaptation strategies (section 4.3.2), and preparedness for future climate shocks (section 4.3.3). Only 27 % of households reported later-than-usual cocoa harvests in 2017 (compared to 71 % in the drought year), again pointing to cocoa's recovery. Although results indicate 'recoveries' in 2017, it must be emphasised that incidences of poverty across multiple dimensions and indicators were significant in the pre-drought baseline year of 2015.

4.2. *Resilient outcomes and their interaction with poverty*

We now examine three specific resilient outcomes – households meeting critical expenditures, implementing adaptive strategies, and being prepared for future climate shocks – and the interaction of these with multiple poverty indicators.

4.2.1. *Meeting critical needs*

Poverty constrains economically-developing communities' attempts to cope with drought, since poorer individuals are also confronted with non-climatic stressors that restrict their ability to emerge resiliently through, and following, a drought (Antwi-Agyei et al., 2012; Sen, 1999; Stringer et al., 2009). In the study villages, smallholder households struggled with non-climatic stressors such as securing food and raising healthy children, even under favourable climatic conditions. The six basic or critical needs (co-identified with smallholders) we focused on in our survey were being able to: obtain an adequate amount of food; obtain an adequate variety of food; keep children in school; afford medicines when needed; afford to go to a healthcare centre when needed; and contribute to funeral expenses.[5]

Figure 4.3.1 [Fig. 4.3.1 here in colours of publisher's choice] presents the distribution of households able to meet each of these critical needs in each month of 2015, 2016, and 2017. Fewer households could obtain an adequate food amount and variety in the drought year; though these two aspects of food security recovered in 2017. Healthcare centre access and funeral expense contributions were also negatively impacted in 2016. The most difficult months for meeting critical needs were January to July 2016 which corresponds to the hottest and driest part of the prolonged drought and the worst of its aftermath (see Hirons et al., 2018 Fig. 2 for meteorological data which corroborates what we found in surveys as the most difficult months for meeting critical needs) and adds to evidence that livelihood impacts of climate related shocks are strongest in the short term (Cooper et al., 2008; Creedy et al., 2022; Maganga et al., 2021).

We quantified (per Table 3.1) the extent to which each household could meet basic needs in each of the three years. As Table 4.3.1 shows fewer critical expenditures were met in 2016 than in 2015, further demonstrating the immediate negative impact of the drought on households. However, Table 4.3.1 also shows that households met significantly more critical expenditures in 2017 than in both 2015 and 2016, further evidencing a post-drought 'recovery'.

We now examine the statistical associations between household critical needs scores and 38 poverty indicators. In total, in 2015, 16 indicators spanning six different dimensions of poverty were found to be significantly associated with meeting critical needs (see Table 4.3, Supplementary Materials). More favourable indicators of household income, health, basic needs, asset access/ownership, and land assets were all significantly and positively associated with households meeting

[5] Elaborate funeral ceremonies are integral to Ghanaian culture (Debrah, 2013; Kutsoati and Morck, 2014). Societal pressure to contribute to funeral expenses is strong; it is an expectation (Bonsu and Belk, 2003; Mohan, 2006). Attending and financially contributing to funerals represent significant social capital to community-level relations which in turn could improve one's experiences of at least two dimensions of poverty: social connectedness and empowerment (Bawa, 2016).

Fig. 4.3.1. Month-by-month breakdown of when households were unable to meet specific critical needs.

Table 3.1
Summary of the different resilient outcomes and how we quantified them in our analyses.

Resilient outcome	How quantified	Range
Meeting critical needs (all years)	+1 for each of 6 critical needs household met throughout year	0 to 6
Implemented adaptation (2016 & 2017)	+1 for each adaptation already implemented by household (from 9 prompts); +1/+0.5/0/-0.5/-1 for extent of agreement (Likert scale) with five statements about drought adaptation	−5 to 9
Future drought preparedness (2016 & 2017)	+1 for each adaptation planned by household (from 9 prompts, with free response option); +1/+0.5/0/-0.5/-1 for extent of agreement (Likert scale) with five statements about drought preparedness	−5 to 9

more of their critical needs.

Poverty is widely deemed to be a dynamic phenomenon "shaped by the interplay of social, economic, political, and environmental processes" (Leichenko and Silva, 2014, p.540), shifting in response to external stimuli such as climate shocks (Birthal and Hazrana, 2019; Hansen et al., 2007), and this was the case in this cocoa smallholder cocoa cultivation system since the picture was markedly different during the drought year, 2016 (see Table 4.4, Supplementary Materials). Only seven indicators of poverty were statistically associated with meeting critical needs under drought conditions. Two of these also featured in 2015 as well, *viz*. adequate access to healthcare and goat ownership, which were both associated with higher critical needs scores in 2016. Using longitudinal survey data, Maganga et al. (2021) also found farmers' drought resilience strengthened through livestock ownership.

It is notable that annual cocoa incomes, harvests, and cultivation areas were *not* found to correlate with meeting critical needs during the drought. Non-cocoa income was similarly uncorrelated with meeting critical needs. Income alone did not help people meet their basic needs during a prolonged drought, which highlights the salience of multidimensional approaches to understanding poverty. Frequent agronomic advice neither correlated with critical needs scores in 2016. This is perhaps unsurprising, given that formal agronomic advice has tended to focus on closing yield gaps and boosting cocoa productivity (Abdulai et al., 2020; Amponsah-Doku et al., 2021; Gockowski et al., 2010), rather than drought coping mechanisms or sustaining livelihoods (Belay et al., 2017; Maguire-Rajpaul et al., 2020). The fact that receiving frequent formal agronomic advice did not boost productivity sufficiently to alleviate several dimensions of poverty underscores the need for resilience and agronomic extension interventions to look beyond raising cash crop productivity so as not to entrench poverty along multiple dimensions. Indeed, Iddrisu et al. (2020) and Garrett et al. (2021) found productivity gains following certification extension improved neither livelihoods nor food security. These two studies corroborate what we heard in interviews and focus groups that when farmers increasingly specialise in cash cropping, they spend proportionally more buying food for subsistence.

In the post-drought year (see Table 4.5 in Supplementary Materials),

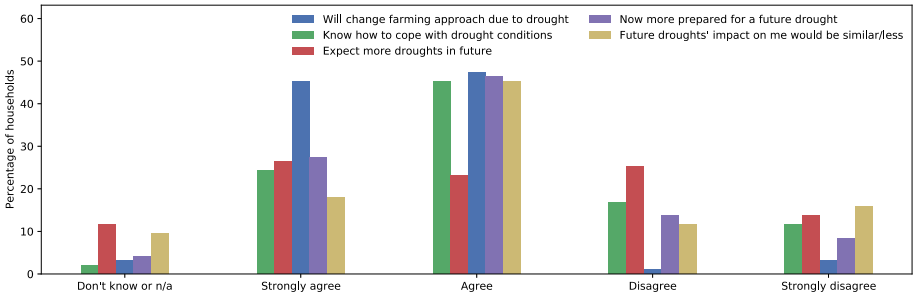

Fig. 4.3.3. Distribution of responses to five statements about drought preparedness and *planned* adaptation.

Table 4.2
Pre-drought poverty dimensions and indicators from 2015, and the distribution of responses (*N=95*, unless otherwise specified) across surveyed households. Notes: (1) Two households had only recently established their cocoa farms and their trees had not yet yielded. (2) Each device or service analysed as a separate poverty indicator. (3) Each vehicle analysed as a separate poverty indicator. (4) Summarised from 14 finer-grained categories of responses, e.g., "3–6 times per year". (5) Shared labour group; (6) Shared savings group.

Poverty dimension	Indicator	Distribution of responses (2015)
Income	Annual cocoa income, from direct sales and trading (cedis)	μ = 7390, M=3990, SD=9237 (range: 350–40000)
	Annual non-cocoa income (cedis)	μ = 2413, M=1080, SD=3919 (range: 0–27000)
	Annual cocoa harvest (kg) [1]	μ = 862, M=640, SD=1001 (range: 0–6912)
	Livelihood diversification (no. of income sources not related to cocoa)	μ = 4, M=4, SD=2. Common income sources: annual crops (73 %), commodity trading (53 %), oil palm (47 %), remittances (34 %), daily cocoa labouring (27 %), skilled labour (21 %), livestock (20 %)
	Have enough savings to cope with a year with low cocoa yield	Strongly agree: 16 %; agree: 36 %; disagree: 18 %; strongly disagree: 27 %; don't know: 3 %.
	Weekly food expenditure (cedis)	μ = 87; M=70; SD=120 (range: 0–1050)
Health	Poor health frequently affects household	Strongly agree: 38 %; agree: 32 %; disagree: 21 %; strongly disagree: 9 %
	Household has adequate access to healthcare	Strongly agree: 20 %; agree: 60 %; disagree: 16 %; strongly disagree: 4 %
	Under-5 mortality in past	Yes: 18 %; no: 82 %
Education	Education completed (household representative)	No formal: 21 %; primary: 24 %; junior high: 49 %; senior high: 5 %; vocational 1 %
	Literacy level (household representative)	Illiterate: 45 %; read only: 11 %; read and write: 44 %
Basic needs	Electricity access	No: 34 %; grid: 63 %; shared from grid: 1 %; own generator: 2 %
	Sanitation access	No: 11 %; yes: 59 %; shared: 31 %
	Clean drinking water access	No: 9 %; yes: 48 %; shared: 42 %
Assets	Devices and associated services[2] (ownership or shared access)	Radio (74 %); TV (35 %); mobile phone (72 %); bank account (53 %); mobile money account (33 %); refrigerator (12 %);
	Vehicles[3] owned	Bicycle (13 %); motorbike (10 %); car/other (10 %)
	Motorised spraying machine	No: 25 %; yes: 26 %; share: 8 %; rent: 40 %
	No. of goats owned	μ = 2.2, M=0, SD=5.6 (range: 0–42)
	No. of chickens owned	μ = 20.3, M=10, SD=30.5 (range: 0–250)
	Other livestock owned	One household owned one head of cattle; two households owned pigs (4 and 6 pigs, respectively). No horses or donkeys.
Land assets	Cocoa cultivation land area (acres)	μ = 7.9, M=6.4, SD=8.0 (range: 0–53)
	Oil palm cultivation area (acres)	μ = 1.2, M=0, SD=2.7 (range: 0–20)
	Total cultivation area across all crops other than cocoa and oil palm (acres)	μ = 2.3, M=1.6, SD=3.0 (range: 0–17)
	Homestead area (acres)	μ = 0.78, M=0.40, SD=1.46 (range: 0–12)
Food security	Adequate food amount (past year)	Yes: 65 %; no: 35 %
	Adequate food variety (past year)	Yes: 80 %; no: 20 %
Empowerment	Easy to access more cocoa land?	Strongly agree: 20 %; agree: 22 %; disagree: 44 %; strongly disagree: 12 %; don't know: 2 %
	Any influential position in village (e.g. elder, committee member, pastor)?	Yes: 39 %; no: 61 %.
Social connectedness	Social group membership	65 % belonged to at least one social group; 35 % belonged to none. Common memberships: church group (20 %), Enobua[5] (20 %); Susu[6] (4 %); farmers' association (3 %)
	Buying company/purchasing clerk agronomic advice frequency[4]	At least monthly: 12 %; at least annually: 23 %; less than annually: 3 %; never: 62 %
	Agri-officer agronomic advice frequency[4]	At least monthly: 5 %; at least annually: 47 %; less than annually: 7 %; never: 41 %
	Friend/neighbour agronomic advice frequency (*N*=29 responses only)	More than once a month: 34 %; monthly: 48 %; at least annually: 18 %

only two poverty indicators were associated with meeting critical needs. The first was livelihood diversification which, unlike in 2016, was now associated with meeting *more* critical needs. Based on insights from 2016 and 2017 focus groups and interviews, we infer that this change was because many subsistence crops failed during the drought (in which case some households lost both income and food sources), whereas most subsistence crops had recovered by 2017 meaning more households could secure an adequate amount and variety of food: two of their six critical needs. Focus group discussants noted that failure of local food crops through the prolonged drought led to elevated prices at local markets, but that these had largely returned to normal by 2017.

The second indicator associated with meeting 2017's critical needs was adequate healthcare access, which featured similarly in the two previous years as well. In all three years, this poverty indicator of healthcare access was associated with the resilient outcome of meeting critical needs, suggesting that healthcare investments could support the

Table 4.3.1
Quantification of the extent to which each household could meet basic needs in each of the three years, with a given household able to score between 0 and 6 each year. A one-tailed Mann-Whitney test indicated that fewer critical expenditures were met in 2016 than in 2015 (U=5144.5, $p = 0.045$), and that more critical expenditures were met in 2017 than in both 2015 (U=3231.5, $p < 0.001$) and 2016 (U=2624.0, $p < 0.001$).

Year	Critical needs score
2015	μ = 3.86, SD=1.81
2016	μ = 3.42, SD=1.86
2017	μ = 4.73, SD=1.51

resilience of smallholders. The many ways in which the drought impacted health were detailed in interviews. Several interviewees described how hot their houses became, causing heat rashes and diarrhoea. Reduced incomes meant it was *"expensive to afford taxi fares to carry sick people to hospitals"* and that those who could travel to hospital did not always recover because *"national insurance only covered a doctor visit, but not the medication"*. A focus group discussant reported in 2016: *"income levels have been badly hit, and now when there is any illness, you will probably die or get worse"*. Interviewees illuminated the difficulties of farming as usual under drought conditions when they themselves were in resultant poor health. The households which struggled to pay for essential medication or secure enough food or potable water explained they were less able to adapt to the drought or prepare for future droughts.

4.2.2. Implemented adaptation

To quantify the extent to which a household had implemented drought adaptation, and compare this with poverty indicators, we computed "implemented adaptation scores" (see Table 3.1). Across all households, the mean (SD) implemented adaptation score was 1.87 (2.25), well below the maximum possible score of 9. The minimum computed score for any household was −4.0, close to the minimum possible score of −5. Both scores suggest that cocoa households may encounter barriers against implementing drought adaptation. Indeed, cocoa smallholders facing adaptation barriers has been widely reported (Afriyie-Kraft et al., 2020a; Akrofi-Atitianti et al., 2018; Denkyirah et al., 2017; Maguire-Rajpaul et al., 2020). For instance, few households reported nurturing timber or shade trees around cocoa, despite widespread promotion of shade trees as an adaptive, resilient, and climate-smart strategy for cocoa cultivation. Smallholder inability to nurture timber or shade trees is often not due to a lack of volition, but rather insecure land and tree tenure issues (Asare et al., 2019; Damnyag et al., 2012; Hirons et al., 2018; Maguire-Rajpaul et al., 2022). More cocoa households could implement adaptation if barriers preventing them were recognised by interventions, and how these barriers to adaptation are affected by dimensions of poverty were recognised then embedded into interventions' policies, e.g. accessing clean drinking water and securing adequate food amounts are pre-requisites for being healthy enough before implementing adaptive strategies or preparing for future droughts.

The most frequent adaptive strategies implemented in response to the drought were increasing food crop storage, saving money from harvests, and finding wetland to farm (See supplementary Fig. 4.5). It is noteworthy that the most capital intensive adaptive strategy of digging wells was the least implemented (and least planned). Without adequate savings or a loan possibility, cocoa smallholders will struggle to implement capital intensive technologies to boost climate resilience (Wongnaa and Babu, 2020).

When considering statistical associations between poverty and the resilient outcome of implemented adaptation, six indicators across five poverty dimensions were associated with implemented adaptation (Table 4.6 in Supplementary Materials). Higher cocoa incomes, higher literacy levels, access to clean drinking water, goat and chicken ownership, and adequate food amounts were all associated with higher implemented adaptation scores. Without safe potable water and securing adequate food, households focus more on day-to-day survival through a climate shock than on building resilience with medium- to longer-term adaptation. As was the case with meeting critical needs, it is evident that multiple dimensions of poverty – not just cash crop income – interact with resilience, as measured in this case by the extent to which households had implemented drought adaptation.

Table 4.3.4
Poverty dimensions (rows) and indicators found to have statistically-significant associations with resilient outcomes (columns), summarising key results in Supplementary Tables 4.3—4.7. For a given resilient outcome, poverty indicators are listed in decreasing order of statistical significance. Brackets denote poverty indicators with a statistical association with a resilient outcome significant only at a $p \leq 0.10$ level; non-bracketed indicators have associations that are significant at $p \leq 0.05$. Asterisks denote a negative association, such that greater poverty was associated with a more resilient outcome. A total of 37 (32 positive and 5 negative) statistical associations are summarised here.

	Critical needs (2015)	Critical needs (2016)	Critical needs (2017)	Implemented adaptation	Future drought preparedness
Income	Non-cocoa income, $p = 0.006$; cocoa income, $p = 0.03$; (cocoa harvest, $p = 0.10$)	Livelihood diversification – no. income sources*, $p = 0.05$	(Livelihood diversification – no. income sources, $p = 0.06$)	(Cocoa income, $p = 0.09$)	Livelihood diversification – no. income sources,* $p = 0.05$
Health	No under-5 mortality, $p = 0.02$; healthcare access, $p = 0.04$	Healthcare access, $p = 0.008$	(Healthcare access, $p = 0.06$)	–	–
Education	–	–	–	Literacy level, $p = 0.04$	Literacy level, $p = 0.05$
Basic needs	Clean drinking water access, $p = 0.003$; (electricity access, $p = 0.06$)	–	–	Clean drinking water access, $p = 0.02$	Clean drinking water access, $p = 0.05$
Assets (ownership or access)	Radio, $p < 0.001$; mobile phone. $p = 0.008$; TV $p = 0.01$; (goats, $p = 0.08$); (chickens, $p = 0.08$)	TV, $p = 0.008$; spraying machine, $p = 0.05$; (goats, $p = 0.07$)	–	Chickens, $p = 0.04$; (goats, $p = 0.06$)	(Goats, $p = 0.07$)
Land Assets	Oil palm cultivation area, $p = 0.01$; (cocoa cultivation area, $p = 0.07$)	Homestead area, $p = 0.03$	–	–	–
Food security	n/a	n/a	n/a	(Adequate food amount, $p = 0.09$)	Adequate food amount, $p = 0.04$
Empowerment	–	Position of influence in village, $p = 0.02$	–	–	–
Social connectedness	Agri-officer advice frequency, $p = 0.005$; (social group membership*, $p = 0.10$)	–	–	–	(Friend/neighbour advice frequency,* $p = 0.06$); (social group membership,* $p = 0.10$)

4.2.3. Preparedness for future droughts

Precautionary planning for future adaptation assistance could prove a more beneficial type of poverty alleviation intervention than post-shock relief since it could alleviate some *causes* of struggling to cope through droughts and other climate shocks, rather than merely symptoms. How resource-constrained actors respond to environmental crises and change their behaviour henceforth varies enormously. Several conceptual approaches explore how people cope, learn to adapt, prepare, and transform following environmental shocks; these include experiential learning (Armitage et al., 2008; Turner and Berkes, 2006), cognitive reflection, and social learning (De Kraker, 2017; Tschakert and Dietrich, 2010). In our analyses, preparedness and adaptive planning were constituted by how those surveyed responded to statements about future climate shocks. Drawing again on themes that emerged repeatedly in focus groups and interviews, we surveyed household representatives about the extent to which they agreed with five statements related to preparedness for future droughts. Figure 4.3.3 below [Fig 4.3.3 here or just below, in colours of publisher's choice] shows the five questions, and the distribution of responses to each.

To examine preparedness for future droughts, we computed (see Table 3.1) a preparedness score per our implemented adaptation scores, whereby a weight was assigned to the extent of agreement with the five statements (cf. Fig 4.3.3) about drought preparedness. Across all households, the mean (SD) preparedness score was 2.40 (1.75), well below the maximum possible score of 9, suggesting that households' dimensions of poverty may have prevented preparing for future droughts. One might expect that experiencing a drought might encourage precautionary planning to mitigate the effect of future climate shocks. Such widespread drought preparedness was not the case among these cocoa smallholders who detailed a range of barriers preventing them adopting adaptative measures. Recurrent barriers across the sample were insecure tree and land tenure preventing smallholders from planting and nursing shade trees, and insufficient agronomic extension specifically on adapting to and preparing for drought and high temperatures. Additionally, 39 % of surveyed households and many focus group discussants said they did not expect any more droughts in the future which goes against climate modelling for the region (Hutchins et al., 2015; Schroth et al., 2016). Such optimism seems inconsistent with the adverse experiences during the prolonged drought and its aftermath, and could also suggest a need for more culturally- and contextually-appropriate extension services specifically on climate shocks.

Examining statistical associations between poverty indicators and the resilient outcome of drought preparedness reveals seven indicators across six poverty dimensions were associated with implemented adaptation. As with the previous two resilient outcomes we considered, in the case of future drought preparedness, multiple dimensions of poverty were found to be associated with resilience. Higher literacy levels, access to potable water, goat ownership, and adequate amounts of food were all associated with higher *preparedness* scores. We note that all four of these indicators were associated with more *implemented* adaptation too (see Supplementary Material Table 4.7). Goat ownership was also one of the few poverty indicators that correlated with meeting critical needs during the drought year, corroborating Maganga et al.'s (2021) finding that smallholder drought resilience is bolstered by livestock ownership.

Greater livelihood diversification was associated with *lower* preparedness scores; we recall (Section 4.3.1) that livelihood diversification was also associated with meeting *fewer* critical needs in the drought year. We infer from interviews and FGDs that households managing several income streams had less time to prepare for future droughts. However, perhaps more important than the number of income streams would be the extent to which a household can rely on these for steady income (such as palm yielding fortnightly). Reliable income alternatives are not something we explicitly explored. Somewhat surprisingly, social group membership and receiving agronomic advice from neighbours or friends were associated with *lower* preparedness scores. We might infer that social groups and informal sources of agronomic information were not necessarily ideal sources of advice for preparing cocoa farms and households for future climate shocks. If so, this may suggest a need for more culturally- and contextually-appropriate extension services, specifically on climate shocks. Wongnaa and Babu's (2020) study on drought resilience among Ghanaian cocoa farmers recommended farmers join organisations with extension officers trained in educating farmers on climate change resilience strategies. When extension officers or others giving resilient preparedness advice are also aware of the community's dimensions of poverty and barriers to adaptation faced, interventions could be more holistic and potentially more effective for precautionary planning to stymie the impacts of future climate shocks.

4.2.4. Summary of the associations between poverty and resilient outcomes

[Table 4.3.4 here in the colours used above as each colour corresponds to one poverty dimension and repeats across tables] Table 4.3.4 ties together key findings from Sections 4.3.1—4.3.3 (and Supplementary Tables 4.3—4.7), summarising dimensions and indicators of poverty that evince statistically-significant associations with resilient outcomes. Table 4.3.4 shows that each of the nine poverty dimensions considered was statistically associated with at least one resilient outcome, and in the direction expected *a priori*: i.e., less poverty (e.g., better healthcare access) was associated with a *more* resilient outcome. This accords with our premise that farmers who are poorer (along multiple dimensions of poverty) would prove less resilient to climate shocks.

The income from cocoa indicator was associated with only two out of five[6] resilient outcomes considered, and one of those times at a significance of only $p \leq 0.10$. A crucial reflection of this paper is that because annual cocoa incomes, cocoa harvests, and cocoa cultivation areas were *not* found to correlate with meeting critical needs either during the drought or its aftermath, or with preparing for future droughts it is important for resilience interventions to engage with factors beyond cocoa income. Continued focus on cocoa yields (e.g. through sustainable intensification) is often legitimised by the argument that this would boost farmer resilience. Our results show that this is a necessary –albeit insufficient – strategy for promoting resilience and poverty alleviation in cocoa communities. There are other key investments, such as, healthcare or potable water infrastructure, or supporting landscape-level food security which could bolster resilience and alleviate poverty.

Iddrisu et al. (2020) – who found that any increased cocoa productivity and income from the intervention of certification didn't necessarily lead to enhanced food security – recommend that interventions should consider food security indicators. Obtaining enough food and an adequate variety comprised two of the six critical needs, so to avoid double counting we did not analyse associations between aggregate critical needs resilient outcomes and the dimension of food security. Our survey results on securing adequate amounts and variety of food along with details divulged in interviews and FGDs demonstrate that household food security represents a necessary foundation for resilience. Smallholders explained how without adequate food, implementing adaptation and preparing for future droughts prove insurmountable.

Across all nine poverty dimensions and the resilient outcomes considered, there were 38 poverty indicator/resilient outcome pairs that evinced statistically significant associations. 34 out of 38 (89.5 %) of these associations were in the direction expected *a priori*. In the drought year, greater livelihood diversification was associated with meeting *fewer* critical needs (and with *lower* preparedness scores). The other three out of the four pairs evincing associations in the unexpected direction involved the dimension of social connectedness. Although social

[6] The five resilient outcomes considered include all three years of meeting critical needs, implemented adaptation, and future drought preparedness (per Table 4.3.4's columns).

connectedness and group membership were highly valued within the studied communities, they appear less important for climate resilience. Considering this result in tandem with cocoa community engagement, we infer that informal advice from social groups, friends, and/or neighbours may have been suboptimal for engendering drought resilience. For improved drought resilience among Ghanaian smallholders, extension officers need specific training on climate-resilience strategies (Wongnaa and Babu, 2020) and to deliver them in culturally-appropriate ways (Maguire-Rajpaul et al., 2020). The adaptation barriers of illiteracy and inadequate food could be lowered if they were embedded into interventions' policies (Iddrisu et al., 2020). Recognising barriers to adaptation and ways to remedy them could assist smallholders implement their desired adaptation and facilitate their future preparedness.

Along with food security and literacy, other dimensions of poverty that showed strong and recurrent associations with our resilient outcomes were clean drinking water, healthcare, diverse livelihood sources, access or ownership of assets particularly goats and chickens. Livestock ownership was positively associated with four out of five resilient outcomes which corroborates Tesfaye and Tirivayi (2020), Thornton and Herrero (2015), and Maganga et al. (2021) who emphasise that livestock represent an important buffer against poverty and can strengthen climate resilience among SSA farmers. There is some overlap between the most recurrent dimensions of poverty that we found and Maganga *et al.*'s longitudinal study (2021); as well as with Denkyirah *et al.* (2017) who found that literacy, diverse livelihood sources, access to extension services, household size, and cocoa income influence cocoa farmers' adaptation strategies; and with Wongnaa and Babu (2020) who found that diverse livelihood sources, access to extension services, and cocoa income from cocoa production influence adoption Ghanaian cocoa farmers' adaptation strategies. Our results and these other studies underscore the salience of multidimensional approaches to understanding poverty and its impact on resilience against climate change and climate shocks, thereby highlighting the resultant need for cash-crops interventions to appraise wider poverty issues and barriers to resilience and adaptation. Our results and pluralistic approach show that managing drought for the climate-threatened cocoa crop requires a holistic appraisal of smallholder livelihoods and the whole social-ecological system.

5. Conclusions

Without meaningfully considering affected people's vulnerability, or how climate impacts poverty, or normatively asking 'what is being maintained and for whose benefit?' (Cote and Nightingale, 2012; Cretney, 2014; Cutter, 2016; Quandt, 2018), resilience interventions risk entrenching disadvantage and exacerbating inequalities (Bahadur and Tanner, 2014; Matin et al., 2018). This paper advanced knowledge by combining the assessment of resilience with multi-dimensional understandings of poverty, based on farmers' own experiences and perceptions.

Resilience interventions tend to operate in silos and focus on technical fixes (such as intensifying productivity). This paper departed from technical views of resilience by centring on smallholders' livelihood concerns and experiences of poverty (as opposed to questions of agricultural productivity and outputs that maintain the status quo). We turned our attention to multiple dimensions of poverty, vulnerabilities, and social-ecological interactions by developing an integrated resilience-poverty framework, treating both concepts multidimensionally. Multidimensional approaches to poverty broaden poverty beyond monetary deprivations. In like manner, we broadened resilience to consider multiple resilience "outcomes" as experienced then voiced by smallholders affected by a climate shock. Our foundational premise was that neglecting multiple dimensions of poverty could lead to inadequate resilience-building, delivering deficient human development outcomes. Our two-part research question asked: i) 'how do experiences of poverty undermine resilience?', and ii) 'which dimensions of poverty influence resilience?'. All poverty dimensions considered were statistically associated with at least one resilient outcome in the direction expected *a priori*: demonstrating that farmers who are poorer along multiple dimensions of poverty are less resilient to climate shocks. Two key findings are: i) cocoa income alone didn't help farmers meet their basic needs during prolonged drought, and ii) cocoa income was associated with only two out of five resilient outcomes considered, and one of those times at a significance of only $p \leq 0.10$. Both findings highlight the salience of multidimensional approaches to understanding poverty and underscore the need for resilience interventions to look beyond raising cash crop productivity.

Before the drought, surveyed cocoa smallholders already faced material and structural poverty, alongside inadequate access to public services and persistent food insecurity. Such multidimensional poverty suggests systemic issues in the global cocoa value chain and potential exploitation of smallholder labour (LeBaron and Gore, 2020; Odijie, 2018). The drought exacerbated their situation, leading to subsistence crop failures, reduced cocoa harvests, and widespread food insecurity, with 65 % of households unable to afford meals. The pursuit of resilience – particularly when serving corporate interests – can often overlook such structural and intersectional determinants of vulnerability and poverty (Jackson, 2024; Thompson et al., 2022). We found this to be particularly the case for global cocoa's buyer-driven governance which narrowly equates resilience with sustaining or intensifying cocoa production without further deforestation reputational risk (Grabs, 2017; LeBaron, 2021). A crucial reflection of this paper is that because annual cocoa incomes, cocoa harvests, and cocoa cultivation areas were *not* found to correlate with meeting critical needs either during the drought or its aftermath, or with preparing for future droughts, it is important for resilience interventions to engage with factors beyond cocoa income.

Farmers testified that increased specialisation in cocoa meant spending proportionally more money buying food for subsistence, and worsened food security. Continued roll out of resilience interventions around yield intensification and/or 'climate-smart' goals of a single cash crop risks entrenching multiple dimensions of poverty. When socio-economic contexts go ignored, or when interventions address only climate change *impacts* rather than underlying *drivers* of what makes a community vulnerable to climate change, such interventions might unwittingly exacerbate social disadvantages by: deepening vulnerabilities; reproducing suffering along multiple dimensions of poverty (Jennings, 2011: 238); proving ineffective (Carpenter et al., 2012; Schipper, 2022); resulting in maladaptation (Bertana et al., 2022; Schipper, 2020); or ignoring which specific resources alleviate poverty, enable adaptation, and/or boost climate-resilience. For instance, our longitudinal analyses revealed that farmers with livestock evinced more resilience. Higher scores for implementing adaptation were associated with goat and chicken ownership, literacy, potable water access, and adequate amounts of food.

The mean implemented adaptation score of 1.87 (SD 2.25) falls well below the maximum of 9. Low levels of adaptation and preparedness among cocoa households can be somewhat explained by a holistic examination: for instance, fewer than half of surveyed households had access to potable water. Factors such as limited access to potable water, food insecurity, insufficient income, and illiteracy contribute to substantial challenges for promoting resilience. Resilience interventions often prioritise external goals, thereby diminishing farmers' flexibility and overlooking local adaptation barriers (Cavanagh et al., 2017; Taylor, 2018). Efforts to enhance resilience must address contextual factors and common barriers like land tenure, agronomic support, drought preparedness, and access to credit, in addition to addressing basic needs like water, food, and healthcare.

We found that income diversification's impact on poverty is limited due to financial exclusion, inadequate market access, and structural barriers like illiteracy, tenure insecurity, and lack of potable water. Therefore, efforts to enhance household resilience should be

comprehensive and contextually tailored. Another key conclusion concerns the importance of thinking multidimensionally, holistically, and contextually. Holistic approaches can illuminate complex trade-offs and barriers that smallholders endure, as well as illuminate how vested corporate interests promote a narrow vision of resilience focussed on sustaining cocoa cultivation. Investing in safe drinking water infrastructure, supporting landscape-level food security, supporting income diversification, and improving healthcare could bolster resilience in cocoa communities, yet these poverty aspects are not central in climate-smart or resilience interventions.

To build towards socially-just, pro-poor resilience, we advocate more contextualised ethnographic approaches and hearing affected communities' perspectives. Bronen and Cochran (2021) warn of "danger and damage … when outside academics define food security, resilience, and adaptation" (p.1245). Therefore, this paper's dimensions and indicators of poverty and resilience proxies were co-defined with cocoa smallholders. Our scoping interviews and focus group discussions invited smallholders to share their experiential expertise and recount contextually-relevant details to how the 2015–16 drought impacted their livelihoods, along with adaptation innovations they had employed. As all dimensions and indicators of poverty and resilient outcomes were co-determined with smallholders affected by the prolonged drought, these insights provide important contextual relevance.

This paper politicises climate resilience by fusing it to multiple dimensions of poverty. Our contributions to the literature and policy of resilience include integrating poverty to resilience, and treating both as multidimensional. Using a longitudinal dataset spanning a major drought, we examined how different dimensions of poverty influence smallholders' climate resilience. Three dimensions or outcomes of resilience were co-identified with cocoa smallholders: i) meeting basic needs, ii) adaptation implementation, and iii) preparedness for future droughts. The nuanced relationships this study revealed highlight the value of contextualised and longitudinal empirical data in examining and pursing resilience.

CRediT authorship contribution statement

V.A. Maguire-Rajpaul: Writing – review & editing, Writing – original draft, Visualization, Validation, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **M. Hirons:** Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Project administration, Investigation, Funding acquisition, Data curation, Conceptualization. **V.M. Rajpaul:** Writing – review & editing, Writing – original draft, Visualization, Software, Methodology, Formal analysis, Data curation. **R.A. Asare:** Writing – review & editing, Resources, Project administration, Funding acquisition, Conceptualization. **E. Boyd:** Project administration, Funding acquisition, Conceptualization. **Y. Malhi:** Supervision, Project administration, Funding acquisition. **J. Mason:** Project administration, Funding acquisition. **A.C. Morel:** Project administration, Funding acquisition. **K. Norris:** Project administration, Funding acquisition. **C. McDermott:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Funding acquisition.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

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