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Perspective

From failure to fairness: A call for accountability within household biogas development

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ABSTRACT

The purpose of this perspective piece is to advocate for a paradigm shift in biogas research, and argues for the need to centre accountability and justice in household biogas development research and discussion. Drawing from biogas literature and the authors' own experiences in South Asia and Southern Africa, the perspective illustrates how a lack of accountability in biogas programmes has led to negative outcomes and harm to beneficiaries of top-down biogas programmes. The article emphasises the critical need for a research agenda that prioritises accountability and justice, particularly in the context of the increasing number of biogas installations driven by carbon credits and international aid. It proposes a dual approach: firstly, an in-depth analysis of the impacts of accountability deficits in biogas projects; and secondly, strategies for effectively embedding accountability into programme design. The perspective also advocates for incorporating restorative justice principles in domestic biogas research, starting from project initiation, to ensure there are plans for amending the harm caused should projects fail to achieve their intended outcomes. This approach is essential for holding governments and institutions accountable in large-scale biogas installation. The perspective concludes with a call for an overhaul of the aid and biogas sectors, highlighting the necessity for systemic solutions and a more profound engagement with the practical challenges of biogas implementation.

1. Introduction

Malawi's Nsanje District straddles the Lower Shire River Valley in the country's far south. Surrounded on three sides by neighbouring Mozambique, the district is isolated and distant from the rest of the country. Although the Shire Valley is heavily populated—the land is agriculturally rich and supports intensive subsistence and commercial farming—life there is precarious. Historically, cycles of drought and flood have wrought havoc within the District, with catastrophic flooding events, such as the aftermath of Cyclone Freddy in early 2023, turning the fertile river valley into a vast lake, displacing hundreds of thousands of people across the region. As one of Malawi's poorest districts (1), the region has attracted numerous interventions designed to improve economic and social outcomes. Small-scale anaerobic digesters, which process organic waste into a methane-rich gas, biogas, which can be used domestically for cooking, would seem a natural fit for such a space:

energy poor and bound to agriculture, with ample organic waste requiring management and a need for the nutrient-rich effluent the digesters produce as an alternative to expensive and imported chemical fertilisers. To this end, between 2016 and 2018 the United Nations Development Programme (UNDP) installed 72 household digesters in villages across Malawi, including 6 in Nsanje. Beneficiaries¹ were promised that the new digesters would transform their lives, that they would 'never need to cut firewood again' and that the gas from the stoves would meet all their cooking needs. Yet, this promise never materialised. UNDP, evaluating the impact of the project in 2021, three years after installation, found that no installation lasted its operational lifespan, with the majority quickly failing or never working at all. Visiting Nsanje in 2022, all that remained of the 6 digesters installed there were fragments: a rusted stove at one house, loose gas piping and an old sulphur trap at another, or the tattered remains of a digester bag being used as roofing on a beneficiary's chicken coop.

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¹ We use the term 'beneficiary' while acknowledging the ways in which it positions biogas owners as passive partners within their own interventions. We use the term as it is both commonplace within the biogas space, as well as because it reflects the top-down approach through which biogas programmes are commonly implemented. Ideally, biogas projects would not have 'beneficiaries', but informed and empowered owners.

Although only scattered pieces of the digesters remained, what has lingered more palpably is disappointment. As we visited households, and heard owners' stories, we listened to the disappointment of individuals who had been promised change and were delivered a failure. We witnessed the frustration of beneficiaries who had contributed labour, who had dug pits and trenches for the installation, or paid others to do it. We saw the pain of those who had provided construction materials from their own land: sand, bricks, and water, while purchasing costly cement. In every discussion, we observed the anger of owners who had collected dung and hauled water over long distances to feed a digester that never produced biogas and the humiliation of homeowners who believed the promises they had been told and were laughed at by their neighbours for taking a chance on something different. For these individuals who were promised a better life, positive change has not occurred, and in some instances, real harm has been done. In a project post-mortem conducted by Mzuzu University, the investigators concede this, noting *'it is clear that most of the respondents did not enjoy the benefit of having the biogas plants considering that they had to put in money and time for the construction works'* (2). Although this critical self-reflection is rare within biogas literature (3), for the owners in Nsanje, it is little consolation, especially given that these stories are not unique to Nsanje, and the UNDP is far from the only organisation funding biogas projects in the country.² Within biogas projects, what is the responsibility of the funder to ensure expected outcomes? When a beneficiary is promised a certain benefit, and that benefit does not materialise, who is liable? When biogas projects fail, who is accountable?

The purpose of this discussion is to critically reflect on the role of accountability in top-down domestic biogas programmes. Our reflection encompasses all projects and large-scale programmes, whether internationally funded, like the UNDP digesters in Malawi, or those funded by national NGOs, charitable organisations, or governments.³ Within this discussion, we draw on a brief survey of contemporary biogas literature, as well as the authors' own extensive experience with biogas project development in Southern Africa and South Asia, to critically interrogate the way in which outcomes, failure and accountability are discussed by scholars, and to draw attention to the real harm that project failure can have on beneficiaries. We find that although the overall body of biogas literature is large, with ample discussion on how to improve and optimise outcomes, discussion of specific projects is thin, and there is scant literature that sheds light on the harm that failed projects can cause beneficiaries. Furthermore, although scholars have criticised international aid in general, the discussion has remained predominantly high level, and there is little literature critiquing accountability within specific international aid projects, and exploring how it has detrimentally affected specific projects and stakeholders. This lack of focus on accountability is particularly true in relation to the biogas literature, which, as we have argued in the past, has a tendency to gloss over uncomfortable realities related to project failure (3), where questions on accountability are lacking and discussion on how a lack of accountability and transparency may impact specific projects is neglected. Who must we, as academics, hold accountable for failure and how can we help the sector learn from failure to stop repetition? What standards should be set, and what injustices are being allowed to continue if we do not enforce accountability? These are the types of questions that need to be asked.

² Between 2022 and 2023 our team visited every biogas plant in Malawi's Southern Region and stories of failure, and disappointed owners, were widespread (3).

³ Specifically, we draw upon fieldwork conducted in Malawi between June 2021 and December 2023. This includes visits to all 72 of the aforementioned UNDP digesters, as well as interviews with key stakeholders related to that digester programme. This opinion piece was inspired by the stories gathered during that period, and we look forward to sharing the empirical results of that study in the near future.

Although increased emphasis on accountability within biogas development discourse is long overdue, this discussion is made increasingly relevant by recent escalations in biogas installations, predominantly financed through carbon trading agreements, which will see tens of thousands of household units installed across Southern Africa, including a planned 10,000 in Malawi, 52,000 in Senegal, and a colossal 84,000 units in Kenya (4–6). How can these investments be safeguarded, and how can we ensure that the harm done in Nsanje is not repeated? We argue that the academic community must urgently engage with accountability within biogas projects, emphasising the need for critical research that highlights the potential harm caused by inadequate accountability measures. With growing international investment in biogas, it's crucial to investigate how accountability should be structured in various contexts and funding models. Failed projects cannot simply be learning experiences for donors, and we must be cognisant of the harm beneficiaries suffer without sufficient accountability and reparation measures in place.

As authors, our experiences with domestic biogas range from positive to mixed, and often outright failure. Consequently, we do not adopt a singular perspective on biogas as either unequivocally suitable or unsuitable, nor do we categorise it as strictly positive or negative as a technological solution for improving lives in the Global South. Our unified perspective, informed by extensive experience as biogas scholars and implementers in both Southern Africa and South Asia, recognises biogas's potential as always inherently context-specific, highlighting our collective concern over its often top-down, techno-centric implementation that regularly neglects the intricate local dynamics it seeks to navigate. This implementation strategy, combined with insufficient critical research into the reasons for frequent failures and questions of accountability, as well as a lack of social practice research examining the nuanced factors behind biogas success or failure, places future projects at significant risk of repeating past mistakes. We are all concerned about the potential for yet more failure in biogas implementation and our collective stance, articulated in this piece, is a call to action for all stakeholders in the biogas domain: it is crucial to undertake a critical examination of existing research and identify what change in approach is necessary to comprehensively understand failure mechanisms, determine accountability, and apply these insights to enhance the design and execution of future projects. A change in approach is vital for making informed decisions about when biogas may or may not be an appropriate solution, regardless of its 'potential' benefits.

2. Failure and accountability

Household biogas has been touted as a multi-benefit solution to various sustainability challenges since the 1960s, with institutions frequently implementing it as a top-down, one-size-fits-all remedy for rural households in response to evolving global issues (7). Following the energy crisis in the 1970s, installations were driven by a growing discourse around the need to promote rural development decoupled from fossil fuels, whilst also reducing deforestation caused by households' burning wood for their energy needs. Later, the Millennium Development Goals focussed on tackling indoor air pollution, poor sanitation, and women's empowerment by eradicating the need for firewood collection and cooking on polluting stoves. Domestic biogas has more recently emerged as a climate change solution and with the signing of the Kyoto Protocol, installations could be funded through carbon financing if carbon emissions are saved.

Yet, despite their potential to solve many societal and environmental challenges, the story of household biogas has been fraught with failure

(3,8,9). Although failure is poorly defined (as it depends on the perspective of the stakeholder⁴), we refer to a large percentage of installed digesters that are no longer in use. This failure has occurred at dramatically different scales and in varied contexts across the globe: at a small pilot scale, such as the 72 UNDP digesters installed in Malawi, to massive nation-wide biogas projects. For instance, by the end of 2015, the number of China's installed household biogas digesters reached 41.9 million, but it has been estimated that only 40–60 % of these were being utilised post installation (10). In India, of the approximately 5 million installed it is also estimated that post installation functionality is anywhere between 40 and 80 % (11,12). Although these figures are staggering in themselves, what is more problematic is that they are only estimates, and the programmes do not possess accurate data on broken or abandoned digesters.

The barriers to successful domestic biogas programmes are well-documented, with numerous studies highlighting common challenges (8,13–16). These include poor construction and installation, technical failures, suboptimal feeding practices, insufficient feedstock, high investment and maintenance costs, operation and maintenance issues, socio-cultural resistance of users, a lack of training provision, and knowledge erosion. Research investigations typically conclude by suggesting that if biogas programmes could enhance aspects like training and maintenance, access to subsidies and loans, design and installation quality, feedstock diversification, and user willingness and motivation, then biogas could be an effective solution, given its significant potential (12,14,15,17). We contend that the current research emphasis and conclusions are misplaced. The core issue with biogas implementation lies in its framing as a one-size-fits-all technological fix for overly simplified problems (18), targeting supposedly homogeneous user groups without considering the diverse local contexts of adoption, because no technology is context-neutral (19). The negative effect of this disastrous approach is compounded by a notable absence of accountability mechanisms for donors and implementing bodies, suggesting that systemic challenges may be creating repeated failures, rather than isolated mistakes. To address this, we must shift our focus towards understanding how this lack of accountability impacts users and investigate how biogas programmes with robust accountability measures from the start could potentially enhance success rates.

We searched biogas literature for studies focussing primarily on accountability, i.e., those pinpointing root-causes of failure and attributing responsibility to the appropriate institutions or stakeholders, as well as those addressing restorative energy justice and the compensation of users or community groups for biogas failures and associated harms, but our search yielded no results. Although this specific search yielded no results, we know that discussions on root-causes of failure do exist. A noteworthy example is Rai's (20) comprehensive study on the early successes of Nepal's national donor funded biogas programme and its subsequent decline in performance following shifts towards greater centralisation and regulation. This work alongside some other valuable studies, sheds light on some critical root-causes of repeated biogas programme failures, including policy mismatches, fragmented governance structures, overly positive reporting, flawed programme design and targeting, particularly in seeing large groups of people as uniform, and the absence of effective control and monitoring procedures. These findings highlight the complex challenges facing biogas initiatives and underscore the urgent need for accountability and comprehensive oversight in the sector (12,21–26). Notably, Ghimire (27), leveraging his extensive experience with biogas programmes funded and supported by the Netherlands Development Organisation, underscores the critical

need for checks, controls, and the enforcement of standards within biogas programmes. The absence of such measures can lead to the installation of sub-standard designs without adequate training or follow-up services, all without repercussions. For a technology reliant on subsidies and international funding, where market forces alone will not ensure accountability and competition, implementing a plan for accountability is crucial. The current academic discourse fails to prioritise the consequences of inadequate accountability in biogas initiatives (18,28). There is a gap in understanding the repercussions for users that lack the means to hold institutions and/or stakeholders accountable for poorly executed biogas programmes or how the lack of accountability is permitting biogas efforts to continue, business as usual, without engaging in the difficult work of reimagining how implementation efforts must be fundamentally redesigned (29).

To grasp the overlooked issue of accountability in biogas literature, we need to consider the broader context of the aid sector more generally. Since the mid-20th century, there has been a surge in economic aid to low- and middle-income countries under the banner of 'international development,' driven by the belief in its potential to stimulate economic growth and alleviate poverty (18). This conviction has persisted despite increasing evidence that such aid often fails to achieve its intended outcomes and does not significantly enhance the economic growth of the recipient countries (30–32). Criticism has been a constant in the discourse on international development aid, highlighting issues such as how it can impose stringent donor conditions, create debt burdens on recipient countries, impose neoliberal policies, suppress local initiatives, promote centralisation, create corruption, and hamper economic growth (30,33,34). Anthropologists have especially delved into critique of international development, examining not only its manifestations, but its foundational ideologies. They have scrutinised the underlying discourses and assumptions that fuel the persistence of aid and the concept of development assistance, despite growing evidence of its ineffectiveness. Influential scholars Arturo Escobar and James Ferguson (18,28) critique the development discourse for how it has categorised regions as "underdeveloped," legitimising interventions by "developed" nations. They argue that development institutions frequently rely on or create oversimplified narratives about the recipient country to justify technological interventions, often without a sufficient understanding of local contexts. Ferguson (28) specifically highlights how development projects tend to depoliticise in-country challenges, effectively removing the complexities of local power structures and political realities from consideration. This perspective fails to address the systemic roots of 'development' challenges, framing them as technical problems for experts to solve rather than complex political challenges requiring trans-disciplinary solutions. Consequently, technological interventions can often exacerbate existing injustices and inequalities by ignoring the socio-political structures into which they are introduced (19). This critique extends to the tendency to blame recipient governments, communities, households, or individuals rather than questioning the fundamental model and approach of development itself. Escobar (18) notes that even when the data shows aid is not working, the dominant discourse remains positive and hopeful, justifying more intervention. This foundational approach to international development significantly impedes accountability and the capacity for critical self-evaluation within international development.

Aid effectiveness is compromised by flawed accountability mechanisms. Specifically, donor agencies are primarily answerable to their own parliaments and domestic interest groups, rather than to the beneficiaries in the recipient countries. This misalignment in accountability is a key factor contributing to ineffective aid programmes (35,36). Development aid culture is inclined to protect donor boards from the complexities of aid delivery, leading to a positive bias in reporting and a reluctance to address failures and accountability (33,37). Yet, as some scholars have drawn attention to, the majority of academic literature focuses extensively on identifying barriers and challenges at the micro-level without adequately interrogating the overarching structures and

⁴ What 'success' and 'failure' are for biogas plants is also poorly defined. A 'failed' plant may have produced valuable outputs for some time, while a 'success' might not perform all its possible functions, but still fulfil a useful role for its owner. Defining 'success' and 'failure' in a meaningful way remains space for further investigation.

institutional models that shape development approaches. This is especially true in the clean cooking sector, one of the most extensively studied areas in the energy service sector in which biogas falls (38). Research within this sector primarily focuses on internal household decision-making factors, neglecting the significant impact of external, multi-level factors such as policies, socio-political contexts, geography, and the governance and funding models of programmes on user decisions. This focus has left a noticeable gap in studies that critically examine the broader approach to aid in this field (39–41). If research is overly focussing on one perspective (the household's), how can we truly ascertain what is causing interventions to fail so they can be learnt from and improved upon?

This critique of aid is mirrored within current biogas discourse, which lacks critical studies that scrutinise the sector's fundamental design, as well as a lack of studies that engage with social practice, geography, and anthropology, to study technology adoption in detail to really understand where success is suited, or how biogas could be further improved upon. Furthermore, there's a noticeable absence of perspectives from the very individuals these efforts aim to assist: the beneficiaries. Beyond biogas, the absence of beneficiaries' voices highlights the need for a fundamental shift in how international aid is discussed and approached, and a redefinition of who aid efforts are accountable to when they fail. This shift is vital to authentically assess the impact and direction of aid efforts. Our call to action highlights the crucial role of enhanced accountability to ensure that aid truly benefits its intended recipients and is in harmony with their aspirations and challenges.

3. Humanising accountability

As we have shown, biogas projects are beset by several commonly cited barriers which contribute to poor outcomes. However, our combined research experiences have led us to believe that, although these barriers may be contributing factors to failure, they are merely symptoms of deeper, systemic issues. The question is, why are biogas projects continuing to be implemented in ways where these known 'barriers' consistently arise?

We contend that the cycle of failure stems from several fundamental issues that have not been adequately addressed: ineffective governance, inadequate policies, and insufficient exploration by social sciences and anthropology to understand the nuanced dynamics of biogas adoption. These shortcomings have led to poor targeting of users who genuinely need and are motivated to use biogas, and critically, there is a significant lack of accountability and robust standards. Essentially, biogas is continually installed in unsuitable households that lack the necessary needs, motivations, conditions, and resources for effective operation. Moreover, poor targeting is compounded by a lack of local capacity, know-how and/or the commitment to manage complex biogas programmes. Crucially, these programmes operate without a regulatory framework to hold responsible parties, including international entities, accountable for substandard services. How does this lack of accountability play out on the ground, and how does it impact those whom these projects are meant to serve?

Although contracts and accountability agreements are generally built into projects, our experience suggests that these are either insufficient or not being enforced. In Malawi, the contractor appointed by UNDP was supposed to guide and supervise the beneficiaries in site selection and preparation. Moreover, it was the contractor's responsibility to install the physical infrastructure and to train beneficiaries in operation and maintenance. Yet, Mzuzu University's post-mortem report, and our own engagement with owners, showed that this did not happen. At several sites the contractor either did not assist the owner with site selection or preparation, or did not personally install the digester, leaving construction to the uninformed owner. Other sites were never visited, with the contractor only providing advice by phone. Furthermore, although most owners described receiving some training on feeding and operation, no owner received any training on maintenance

and troubleshooting and were hence unprepared when issues inevitably arose shortly after commissioning. What stands out most significantly is the post-mortem report did not investigate the governance of this project, only its poor outcomes.

Persistent failure raises important questions about accountability: should the contractor be held responsible for not fulfilling the request, or does the responsibility lie with UNDP for failing to ensure and verify that the necessary support was provided? Beyond assigning blame, a more pressing issue emerges: knowing the importance of training and maintenance, why are biogas installations still proceeding without robust measures to guarantee these services? With abundant data confirming that successful biogas interventions hinge on training and maintenance, should donors and implementing institutions be held accountable for neglecting these best practices, thus wasting beneficiaries' time and resources? We refer to training and maintenance specifically in this project, but the same arguments stand for all the fundamental reasons for failure we have highlighted. Who bears responsibility when biogas programmes inaccurately target adopter households due to a lack of comprehensive understanding of the socio-political, economic, and geographical context? These issues underscore the need for accountability across all fundamental aspects contributing to the programme's failures.

Finally, farmers are not a uniform group of potential biogas adopters (19). Factors such as ethnicity, integration with social and agricultural practices, land access for pasture and farming, and gender roles also significantly influence biogas adoption and utilisation (19,41–43). For instance, gender dynamics play a critical role, with women typically managing cooking and biogas operations, yet decisions and training may favour men, potentially complicating household dynamics and operational efficiency (44,45). All these identified factors will vary within and between even bordering towns and should be understood in every context before biogas projects are instigated. Without leveraging insights from social science, programmes risk misdirecting their efforts, failing to match biogas solutions with users' actual needs and motivations.

If agreements between funders and implementers do not ensure sufficient accountability to protect beneficiaries from poor outcomes, what do funders and implementers expect from beneficiaries? Generally, quite a bit. Biogas subsidies commonly cover installation partially, meaning households contribute some money to installation costs (9,25,26,46,47). If the installations are fully financed then households contribute other resources, as seen in UNDP's case. Firstly, beneficiaries agree to take care of and manage their plants. To manage their plants, beneficiaries commit to provide adequate water and feedstock and to manage the effluent in a sanitary manner. For some, where water is easily accessible and there is abundant animal waste necessitating treatment, these tasks are not onerous. However, in water scarce areas this involves transporting a significant amount of water to fill the digester at start-up and smaller amounts daily afterwards. Moreover, if an owner loses an animal they may need to buy, collect, or transport dung to the plant constantly to maintain digestion. Yet, in Malawi, UNDP had additional expectations of owners. Although the contractor supplied the digester, stove, pipes and fittings, beneficiaries were required to contribute to the construction of the biogas plants as well. If beneficiaries are not able to provide initial inputs, in space, labour, or materials, they risk being excluded from the project. If beneficiaries are not able to maintain their plant, to provide the necessary water or feedstock, they receive no benefits.

Within aid circles it is often posited that because beneficiaries are given technologies, they need no reimbursement when that technology fails, i.e. no harm was done, and the intervention was free. However, as described with the households in Nsanje, this loss often goes beyond the mere failure of a free asset: owners put in real assets towards the success of these projects, investing valuable materials, labour, and contributing to other costs. Yet, despite these stakes, no studies examine the extent of households' losses in money, time, and energy, the impacts thereof, or,

potentially, the mechanisms and responsibilities for reimbursement. In Malawi, when the UNDP found that so many projects had failed, what responsibility did they have to reimburse owners whose plants had not met expectations? What responsibility did they have to document and make transparent why this project failed, as there is a dire need to determine just what it is that lies behind these many failures and few successes of international aid (29). Should these owners be paid back for the cement they bought, the bricks they made, the labour they paid for, or for the farming days they missed out on? How can they be compensated for the disappointment and humiliation? Moreover, who is responsible for these broken promises and lost costs? UNDP? The installer? The owner?

These discussions are critical, because our combined research experience suggests that there are human consequences to this lack of accountability, and that beneficiaries can suffer real harm from failed projects. Across numerous contexts we have seen that a lack of services and accountability make people lose faith in biogas. Across Malawi, we have heard numerous tales of disappointment and anger from owners who were promised a lifestyle revolution, invested their own resources, and ended up with broken systems. Within South Africa we have spoken to beneficiaries who have watched over, and even continued feeding, defunct digesters for years, hoping that one day, someone might come and fix it. Additionally, in India, many households struggle to maintain their biogas systems due to inadequate training in post-installation services from the national programme (12,48). While the government has policies and budgets for training and after-sales services, these are not always provided and there have been instances where neither the contractors nor the beneficiaries were aware of these provisions, leading to plants being left unrepaired (26). Stakeholders we interviewed expressed concerns that insufficient monitoring and quality control are undermining the effectiveness of the Indian programme.

The challenges of assigning accountability become even more pronounced due to the varied typologies of biogas construction. In countries like India, Nepal, China and Vietnam, national programmes typically have installed cement and brick fixed dome digesters made with local materials and constructed by local technicians, keeping accountability of construction quality and lifespan within the country (14). However, biogas digesters come in many varieties such as plastic bags or floating dome digesters that have plastic and or metal parts (14,49). All digester parts and constructions have various life cycles that can complicate accountability upon failure. The entry of private international suppliers into the biogas sector, with companies like HomeBiogas and Sistema.bio introducing diverse bag type digesters, complicates accountability with their varied stakeholder and funding structures. These companies might leverage private financing from households, carbon financing for subsidies, or integrate into nationally financed programmes spreading accountability beyond national borders and amongst diverse stakeholder groups. The introduction of digesters manufactured abroad, as seen with UNDP installations, further complicates accountability. When issues arise, it becomes unclear whether UNDP, the implementers, or the international suppliers should be held responsible.⁵

Globally, we have observed biogas projects fail, and through a lack of accountability from implementers and funders failure becomes the status quo, and beneficiaries, who were meant to gain from the intervention are instead harmed. As the research community, we must intensify our focus on the tangible impacts of these failures and develop frameworks for incorporating accountability into biogas programmes. Only through rigorous investigation and innovative recommendations can we ensure that the expansion of biogas technology proceeds with ethical

⁵ Users we interviewed reported they were told there were guarantees on biogas bags and parts, but had no means of enforcing these guarantees when they were needed. This case study highlights the intricate web of accountability that spans from local to global levels, demanding a more nuanced approach to address and rectify failures within the biogas sector.

responsibility and sustainability at its core.

3.1. Conclusions and recommendations

The purpose of this discussion has been to centre the role of accountability in top-down biogas programmes. Drawing on a brief survey of contemporary biogas literature, and our own observations and experience with biogas development globally, we argue that persistent project failure combined with a lack of accountability, can result in projects that create harm for the individuals for whom they are meant to benefit. Failure, often discussed in macro terms, has become a detached statistical phenomenon, leading to a disregard for its true human impact. Moreover, we feel that academics investigating biogas programme outcomes have not been asking all the right questions.

As biogas scholars, we must start demanding accountability in biogas programmes and international aid more widely so that all biogas programme stakeholders become answerable to their beneficiaries. To this end, we advocate for a fundamental change in the approach to biogas research, emphasising the humanisation of failure rather than perceiving it as a mere statistical occurrence. By adopting this approach, we can more effectively prevent harm, promote sustainable biogas solutions, and make well-informed decisions about their suitability in various contexts. If accountability could be incorporated into biogas programme design, donors, more aware of their potential responsibility for any harm to beneficiaries, may be more diligent in ensuring the success of a project. Alternatively, they might opt for different solutions if the successful implementation of biogas cannot be confidently assured. We believe this shift in perspective is key to promoting responsible, effective, and ethical practices in the biogas sector.

We propose that instead of continually identifying barriers and challenges in different geographic contexts it's time to focus on deeper questions. While we recognise that contextual specificities exist, the broader catalogue of barriers is largely consistent across diverse biogas implementation scenarios. Instead, we should be asking more questions such as: Why do the same barriers persist across many different programmes, and what drives the continual targeting of unsuitable users with simplistic criteria? Why are programmes not reducing the number of installations to allocate more funds for after-sales services? Why is there a push for new programmes without a thorough analysis of past failures, and whose interests are being served by this relentless drive, despite evidence of widespread failures? It is essential to explore how the lack of accountability is continually perpetuating all these unanswered questions. Drawing on the works of scholars like Escobar could offer insights into the discourse and historical contexts underpinning the persistent installation of biogas systems. Such analysis could reveal how positive narratives overshadow data on failures, the vested interests supporting biogas and development initiatives, and why there's a significant gap in research focusing on understanding failures. This approach could also illuminate why the development sector shows little inclination towards self-critique, offering a more comprehensive understanding of the complexities at play.

We recommend that future research in the biogas space should dedicate more efforts into social practice oriented research focusing on observing biogas technology use within specific domestic contexts. This will help identify which types of owners and geographical areas are best suited for biogas adoption. Such in-depth investigations can provide valuable insights into the localised conditions under which biogas adoption is most likely to succeed. This information would help inform and improve the reductive and over-simplified targeting criteria programmes commonly apply now. Furthermore, we advocate for a research focus on accountability and justice in the biogas sector, elevating these themes from peripheral concerns to central priorities. Our recommended research agenda includes two main objectives: Firstly, a rigorous examination and reporting of the real impacts caused by a lack of accountability in biogas programmes. It is essential to identify and expose the effects on beneficiaries, hold stakeholders and

institutions accountable, and seek reparations for any harm done. This approach will create transparency in the sector and enable the sector to move beyond perceiving failure simply as a statistical anomaly or a failed donor initiative of a free technology, to recognising instead its' true, often detrimental, impact.

Secondly, our proposed research agenda must explore how accountability can be effectively integrated into biogas programmes. This step is vital due to the numerous actors and institutions involved in these programmes. Effective accountability measures will vary, each with its own strengths and weaknesses. We must investigate various methods of incorporating accountability and discern which strategies are effective, which are not, and which are more suitable to diverse contexts.

In adopting this dual-focused approach, we encourage researchers to adopt an energy justice perspective, with a particular emphasis on restorative justice (RJ). Recently gaining traction in energy research, RJ, originally from criminal justice studies, interprets crime as a breach of interpersonal relationships, emphasising the need to make things right by focusing on the needs of individuals and communities that have experienced harm. The offender is tasked with amending the harm caused. According to Hazrati and Heffron (50) the real potential of RJ is in its early application, ensuring that all parties understand their obligations to address any damage before a project has begun.

Incorporating RJ into biogas research and initiatives should extend beyond identifying responsibilities in current top-down program structures; it should also inform the redesign of biogas programmes to better align with local practices and community organisation. Recognising the communal aspects of energy access is particularly crucial in the Global South, where societal structures are often underpinned by communal entitlements (19,51). This recognition requires a deep understanding of how collective rights and the communal management of natural resources shape community energy decisions and needs. RJ will facilitate the development of biogas projects that more comprehensively serve community needs and rights, promoting solutions that are sustainable, equitable, and congruent with local customs and resource management practices.

The forthcoming carbon trading agreements mentioned in the Introduction, highlight the urgency and necessity of addressing the issues and research recommendations discussed in this perspective piece. The proposed or commencing projects, which aim to install thousands of digesters on a short time scale run a real risk of perpetuating the failures characteristic of past development aid efforts. The financial model, dependent on aggregating carbon credits over thousands of installations due to the minimal market value of individual digesters, potentially prioritises quantity over quality. This techno-centric strategy, favouring mass installation of a predetermined technology, calls for an urgent reassessment. As we have drawn attention to, there is a concerning lack of research scrutinising the underlying reasons for the ubiquitous failure of biogas programmes to date. Without better understanding around the reasons for failure and success how can we ensure current and future programmes are better? The positivity surrounding biogas discourse, despite evident failures, and the continuation of new programmes without learning from past mistakes, is careless, even cruel considering the harm it can cause biogas users. There's an urgent need to hold governments and institutions accountable for large-scale biogas installations. Redesigning international aid and carbon financing models to enhance the effectiveness of biogas programmes is critical. The implications of the carbon funded biogas projects go beyond just biogas system failures; they are important to climate change mitigation efforts. Should biogas interventions underperform or not meet their goals, stakeholders owe accountability not only to the immediate beneficiaries but also to the global community for not meeting climate change mitigation commitments. True accountability includes providing compensation and exploring alternative ways to reduce carbon emissions, thereby fulfilling their environmental obligations.

Although our focus in this article is on biogas, the issue of lacking

accountability extends far beyond this field: it is a pervasive problem in the entire aid sector. Academia's neutrality and lack of vested interests in project outcomes position us as ideal critical observers, yet as we have argued, there is a tendency towards positive reporting and a reluctance to engage with failure. As academics, we must question whether our lack of critical scrutiny of aid models, culture, and governance, and our failure to prioritise accountability and justice, has contributed to the underperformance in aid and biogas projects. We must commit to addressing the fundamental issues in aid that cause harm, moving beyond superficial analysis of barriers to effect meaningful change. Tackling the pervasive lack of accountability in biogas and international aid is an urgent research imperative, demanding a radical overhaul of both sectors. We can begin this daunting but transformative process by posing critical 'why' questions, holding institutions to account, documenting the harm caused by aid, and advocating for or aiding in the creation of reparations and improvements in practice.

CRediT authorship contribution statement

Natalie Boyd Williams: Writing – review & editing, Writing – original draft, Conceptualization. **Elizabeth Tilley:** Writing – review & editing, Conceptualization. **Marc Kalina:** Writing – review & editing, Writing – original draft, Data curation, Conceptualization.

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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