RESEARCH ARTICLE

Post-disaster agricultural transitions in Nepal

Jessica DiCarlo , Kathleen Epstein , Robin Marsh,
 Inger Måren

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Abstract In Spring 2015, a series of earthquakes and aftershocks struck Nepal. The earthquakes caused significant changes in labor and land availability, cash income needs, and land quality. We examine how these post-earthquake impacts converged with ongoing agricultural shifts. Earthquake-related socio-economic and landscape changes specifically motivate the adoption of cardamom, *Amomum subulatum*, a high-value ecologically beneficial, and low labor commercial crop. We investigate reasons for the increased interest in cardamom post-earthquake, and challenges associated with it. We find that adopting cardamom serves as an important post-disaster adaptation. However, more broadly, unevenly distributed interventions coupled with the high capital costs of agricultural transition exacerbate social differentiation in communities after the disaster. Adoption is often limited to economically better off smallholder farmers. This paper extends previous research on disasters and smallholder farming by highlighting the specific potential of disasters to accelerate agricultural transitions and resulting inequality from the changes.

Keywords Cardamom · Disasters · Himalaya · Rural differentiation · Small-scale agriculture

Abbreviations

VDC Village Development Committee
 DADO District Agricultural Development Office

MoA	Ministry of Agriculture
UN	United Nations
HVC	High-value crop
TFRDC	Tropical Fruits Rootstock Development Center
<i>Terai</i>	Lowland plains
Masl	Meters above sea level
<i>Amomum subulatum</i>	(Latin) Black cardamom, also known as Nepal cardamom
<i>Alnus nepalensis</i>	(Latin) Nepalese alder; <i>utis</i> in Nepali
<i>Khet</i>	(Nepali) Irrigated fields; typically used to cultivate rice and wheat
<i>Bari</i>	(Nepali) Rainfed fields; typically used to cultivate maize and millet

INTRODUCTION

On April 25th, 2015, a 7.8 magnitude earthquake struck central Nepal and was followed by a series of aftershocks, one of which reached magnitude 6.3 on April 26th. A second earthquake of magnitude 7.3 struck on May 12th to the east of the first. Smallholder farming communities near the epicenters in the mid-hills were the hardest hit. Environmental shocks disproportionately affected rural and poor populations engaged in subsistence and small-scale agriculture (Wisner et al. 2013). Given considerable academic and practitioner interest in agricultural development (Diao et al. 2010; Wiggins et al. 2010; Lowder et al. 2016) and sustainability (Rockström et al. 2017), this research builds on the important and burgeoning canon of literature that looks at development strategies involving rural

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livelihoods (Valdés and Foster 2010), livelihood diversification (Gautam and Andersen 2016), smallholder farming (Hazell et al. 2010; Jayne et al. 2010), and agricultural change and poverty (Rigg 2006; Jayne et al. 2014), in light of environmental shocks.

Disaster events can radically change agricultural landscapes (Eklund et al. 2016) and influence the adoption of new farming practices and crop choices (Lin 2011; Altieri et al. 2015; Epstein et al. 2017). Studies on post-disaster agriculture have explored impacts to land-use change (Khan et al. 2015) and productivity (Lesk et al. 2016), showing how disasters like earthquakes can become critical moments of transformation (Folke 2006). Nepal is well-known for various types of disaster risks, primarily related to seismic and climatic events (NSDRR 2008; Pandit et al. 2014). A World Bank report (2005) ranked Nepal 4th in climate risk and 11th in earthquake vulnerability. Given the link between disasters and agricultural change, understanding the capacity of smallholder farmers to adapt to both sudden and prolonged shocks is a central focus amongst both academics and development agencies (Lin 2011). Our work builds on previous examinations of smallholder farming, disasters and agricultural change (World Neighbors 2000; Holt-Gimenez 2002; Shivakumar 2005; Cutter et al. 2010; Lin 2011; Steffen et al. 2011) by examining how disasters converge with ongoing agricultural transitions. Using a qualitative approach, we examine the earthquake's impacts on agricultural production, how the earthquake motivated increased interest towards cardamom, and the challenges associated with crop adoption post-earthquake. We highlight equity implications of post-disaster agricultural transitions by examining the requirements for successful adoption of cardamom in the dual contexts of earthquake damages and pre-existing socio-economic differentiation.

High-value crop adoption in Nepal

Agriculture constitutes much of Nepal's national economy, with over 60% of the population engaged in farming and 37% of the gross domestic product (GDP) resulting from agricultural activities (MoA 2015). Though some large-scale commercial and export-oriented agricultural operations exist, especially in the *Terai* (lowland plains) region, smallholder systems that produce primarily for home consumption and rely heavily on family and local labor prevail throughout Nepal (MoA 2015). Generally, smallholder farms are less than 1 ha, with the average in Nepal around 0.55 ha (FAO n.d.). Smallholder and subsistence plots are especially prevalent in the mid-hills of Nepal, where farmers grow rice, millet, maize and wheat, combined with vegetables, spices and small livestock husbandry. Here, farmers operate within tightly knit

agroecological systems, relying on interactions between crops, forest products, and livestock (Måren and Vetaas 2007; Måren et al. 2013). Farmers have developed farming techniques specifically tailored to the mid-hills landscapes; the knowledge and skills associated with crop production in this farming system have co-evolved over centuries of exposure to disasters including avalanches, landslides and earthquakes (MoSTE 2015).

Agricultural transitions in smallholder systems are prevalent, widespread, and include partial transition from subsistence farming to cash or high-value crops, farm agglomeration and the narrowing of cultivars towards mono-crop and commodity production (Hart et al. 1992; Li 2014; Behera et al. 2016). Such shifts in smallholder communities typically result from multiple market-related influences: changes in land, labor and cash availability (Blaikie and Coppard 1998); non-agricultural opportunities; declining interest in subsistence lifestyles; and rising consumer demand from urbanization and population growth (Blaikie et al. 1998). Many of these factors are present in Nepal (Gartaula et al. 2016), where transitions to high-value crops vary by region and context as farmers adapt to specific environmental and economic influences, including ongoing and sudden climatic changes. For example, shifting patterns in water availability have strained traditional farming across the Himalaya (Eriksson et al. 2009) and increased uncertainties for long-standing traditional cultivars (Aase 2017). Farming communities are highly reliant on hyper-localized water sources such as local springs and rivers for irrigation and drinking water, as well as groundwater availability in forests and pasturelands. Rising temperatures and shifting precipitation patterns have driven the adoption of new technologies such as drought-resistant hybrid crop varieties and elaborate irrigation and piping systems among other adaptations (Eriksson et al. 2009; Chhetria et al. 2012), or have resulted in declining production, particularly for smallholder farmers (Manandhar et al. 2011; Harvey et al. 2014).

Since the 1990s, national policy in Nepal has played a key role in encouraging adoption of high-value market-oriented crops to generate and increase income for small farmers and rural laborers (Takahamake 2001). Nepal's Agricultural Perspective Plan (1995), a 20-year country-wide agricultural strategy, promoted increased cash crop production as a form of agricultural and economic development. Similarly, the 8th (1992–1997) and 9th (1997–2002) Five Year Plans encourage agriculture-led growth to generate income and job opportunities, promoting policies to enable agricultural diversification and commercialization (Joshi et al. 2007). The intensification of agriculture in Nepal has been applied as a rural livelihood strategy, and means of poverty alleviation (Brown and Kennedy 2005), and food security (Sharma 1997).

Nepal's most recent 14th National Plan (2017) targets the development of agriculture for both post-earthquake reconstruction and economic growth.

Livelihood diversification and commercialization of agriculture are long-standing strategies for rural communities (Ellis 2000) to reduce poverty (Thapa et al. 2017), manage risk (Reardon et al. 2001) and adapt to change (Marschke and Berkes 2006). Yet, conversion to high-value crops has important and potentially negative implications for food security (Achterbosch et al. 2014), particularly among smallholders (von Braun 1992; Baiphethi and Jacobs 2009). The majority of mid-hills farmers maintain some level of subsistence cropping to ensure stock for home consumption (field interviews). Risks and benefits associated with commercialization depend deeply on context (Gautam 2011; Kremen and Miles 2012; Kremen et al. 2012), and can alter smallholder farming communities by increasing social inequality (Li 2011, 2014). For example, transitions to high-value potato or tomato crops in the mid-hills led to uneven costs and benefits among farmers (Brown and Kennedy 2005). Past studies on cardamom cultivation in Nepal have shown crop adoption to improve both income generation and food security for cultivators (Sony et al. 2016), as well as increase inequality between cultivators and non-cultivators, specifically in eastern regions of the country (Fitzpatrick 2011).

Cardamom in Nepal

Known as the *queen of the spices* (Sony and Upreti 2017) or *black gold* (Hartkamp 1993), cardamom is the world's third-most expensive spice crop (USAID 2011). Nepal's large cardamom variety (*Amomum subulatum* Roxb.) or

black cardamom (Fig. 1a) comprises 7% of agricultural exports from Nepal (MoAD 2013), and nearly 70% of the world market for this large variety (ICIMOD 2016). Despite lower productivity in kg/hectare when compared to India, Nepali cardamom fetches a higher price than other varieties such as small cardamom or green cardamom (*Elletaria cardamomum*) that are grown in hilly regions of South India, Sri Lanka, Papua New Guinea, Tanzania and Guatemala (USAID 2011).

As one of Nepal's most profitable cash crops, large cardamom enjoys significant interest from both domestic and international markets. Approximately, 67 000 households engage in cardamom farming nationwide with over 90% coming from four eastern districts: Taplejung, Panchtar, Ilam, and Sankhuwasabha (ICIMOD 2016; Sony and Upreti 2017). The country's annual production of an estimated 6600 metric tons contributes over \$20 million (USD) to the national economy (Chaudary and Vista 2015). Such numbers underscore sustained interest in cardamom from the Nepali government and NGO communities (MoAD 2015); and, recent government-led analyses highlight market potential and increasing international market demand (MoAD 2015). However, other research notes that competition from cultivation in India, where approximately 90% of Nepal's cardamom is exported (Sony and Upreti 2017), and Bhutan, can generate price variability and downward pressure (Poudel and Chen 2012). Furthermore, production in the eastern districts has declined due to disease (Sony and Upreti 2017).

Cardamom has long been a viable option in Nepal's mid-hills along with kiwi, vegetables and potatoes. As part of a rising trend in cash crop adoption, cardamom is well-known in the region as a high-value and low labor crop (Gautam

Fig. 1 **a** Black cardamom grown in Sundrawati, Dolakha District, Nepal. **b** Black cardamom (*Amomum subulatum*) intercropped with Nepalese alder (*Alnus nepalensis*) in Dolakha District, Nepal

2011). It is less labor-intensive than growing vegetables and potatoes and requires less fertilizer. Compared with kiwifruit in Dolakha, the high price of cardamom is reported as more stable and, with few value-added products beyond the raw material, Nepali farmers conserve a large percentage of the final sale value. Farmers reported selling cardamom for \$16.70–18.40 USD (Rs. 1800–2600) per kilogram.

While farmers have started to plant cardamom on *khet* fields (irrigated, typically used to cultivate rice and wheat), it is also common to plant cardamom under Nepalese alder (*Alnus nepalensis*) (Fig. 1b). Alder and cardamom both grow well on marshy, degraded land and thus do not compete with other crops for land use. Nitrogen fixing and slope stabilizing alder stands populate naturally on landslide affected, degraded, and freshly exposed sites (Sharma et al. 2008) and create a light-permeable canopy under which cardamom thrives. In the mid-hills, intercropping of alder and cardamom also conserves water, soil and biodiversity, controls for floods and landslides, reforests degraded land, sequesters carbon, and increases soil fertility (Sharma et al. 2000, 2008; Måren et al. 2013).

MATERIALS AND METHODS

Research location

Dolakha is a mountainous district that lies 132 km north-east of Kathmandu. The district consists primarily of south-

facing slopes with some flat valley floors. Administratively, it is divided into 2 municipalities and 48 Village Development Committees (VDCs). Elevations vary from 732 masl (Siteli VDC) in the south to 7148 masl (Gaurisankhar VDC) in the north (Fig. 2).

The first two earthquakes that hit in April 2015 significantly affected this district. However, the third earthquake on May 12th, with its epicenter in Dolakha, caused the most local damage. Over the course of these events, approximately 87% of the houses were destroyed or heavily damaged (UNOCHA 2015). Within Dolakha, we collected data in Boch VDC, Sundrawati VDC, and the district capital of Charikot. Our study locations lie in Dolakha's mid-hills, which are geographically situated between the *Terai* (plains) to the south and the high mountains to the north, at elevations ranging from 600 to 3000 masl. Mid-hills farmers here commonly cultivate subsistence crops of rice, wheat, millet and maize, and are beginning to adopt high-value crops that include potato, cardamom, kiwifruit and green vegetables.

Research design, data collection and analysis

This paper is part of a larger research project on loss and recovery in smallholder farming communities in mid-hill Nepal after the 2015 earthquakes. We collected data over a six-month period with two intensive field months (May–June 2016) using stratified random surveys, semi-structured and informal interviews, focus groups, and secondary data

Fig. 2 Map of the study region in Dolakha District, Nepal. Asterisk denotes epicenter of 12 May 2015 earthquake measuring 7.3 on the Richter scale

from national and district level agricultural offices (see Table S1). This paper draws on findings from the qualitative research that focuses specifically on the accelerated adoption of cardamom. Participants consisted of approximately equal numbers of men and women across a spectrum of age, caste, and community role. We employed purposive and snowball sampling techniques to recruit participants for data collection activities. Interviews were conducted in Nepali and translated into English. We took extensive notes in both Nepali and English in lieu of audio recording, and triangulated qualitative reports through repeated interviews and questioning. Interviews and focus group discussions centered on agricultural trends, inputs and production, post-disaster decision-making, new technologies and programs, relief and recovery projects, development programs, and community forest and land management. We also ethnographically engaged with community members (Herbert 2000; Crang and Cook 2007) by participating in community meetings, weddings, festivals, funerals, minor farm work, and many informal conversations.

RESULTS

We find that the ecological and socio-economic impacts of Nepal's 2015 earthquakes influenced ongoing shifts towards cash crop cultivation, reorienting farmer decisions to increase the adoption of black cardamom, a high-value crop. Post-earthquake shifts in labor and land availability, cash income needs, and land quality converged with an already ongoing shift towards high-value crops. However, after the earthquakes, cardamom emerged as a particularly appealing crop, because cultivation, market and ecological features aligned with farmer priorities brought on by the disaster.

Impacts to agriculture due to the earthquake

The earthquakes devastated agriculture in Boch and Sundrawati, directly impacting communities through livestock mortality and physical damage to infrastructure, farms and the landscape, and indirectly through increased socio-economic pressures on labor availability and cash resources. In the eyes of an officer at Dolakha's District Agricultural Office (DAO), their resounding effects have "set farming systems in the district back 10 years". Productivity loss was pervasive; at the time of data collection in 2016, district agricultural officers projected 40% losses across the district's commercial and subsistence sectors. Interviewees attribute farm level losses to several sources. Farmers noted that the earthquake caused significant damage, including large holes and cracks in the planting surfaces, to both *bari*

(unirrigated) and *khet* (irrigated) planting systems and altered water sources. Following the earthquake, many residents saw a reduction in water quality and quantity, due to infrastructural damage to canals, pipes, and tanks. The earthquakes and subsequent aftershocks and landslides exacerbated erosion issues on steep terraces. Farmers feared planting on damaged fields, because cracks and holes would quickly drain water, increasing the potential for subsequent landslides.

Post-earthquake, widespread livestock death and the pressure to downsize household animal holdings impaired subsistence livelihood practices and farming systems. In addition to providing meat and milk for consumption and draught power, livestock (like cattle, buffalo and goats) provide manure, an essential nutrient input for both subsistence and cash crops. Livestock mortality during and after the earthquakes was concentrated in mountain regions like Dolakha (Nepal ALIA 2015), where the majority of families (> 80%)¹ keep ox, cow, and buffalo along with goats and chickens for home consumption and sale. Many families who did not directly lose animals in the earthquakes were forced to sell them due to lack of space, less time for fodder collection, and a need for income. As one farmer noted, "Our home was destroyed, so we slept in our animal shed after the earthquake. The animals had nowhere to live and we did not have time to care for them, so we had to sell both our goats".

The earthquakes hit in early spring, before the monsoon season when farmers in Dolakha prepare and tend to their fields. Because relief and recovery activities were concentrated in the months directly following, many fields were left fallow as families dealt with immediate infrastructure, public health, and safety measures as opposed to planting. Food aid from the Nepali government and international NGOs like Plan Nepal and the Red Cross supplemented home reserves and prevented widespread food security crises. Despite extensive damages to farms, there were low levels of emergency migration or dislocation, as most residents opted to rebuild within their home village. However, as of spring 2016, the effects of the earthquakes in Dolakha remained highly visible and widespread. Much public infrastructure like roads and buildings, as well as private property, remains damaged despite efforts to reconstruct.

The widespread need for local labor increased labor costs and thus there is a need for income to pay for labor. Immediately following the earthquake, residents across Dolakha, including Boch and Sundrawati, received minor financial support from the Nepali government (three installments of Rs. 2000, 10 000 and 15 000; or roughly

¹ Of 79 households surveyed in Boch and Sundrawati (Epstein et al. in press).

\$18.00, \$95.00, \$145.00 USD at the time) and international and national aid organizations. Residents expressed dissatisfaction as this support was slow to arrive, insufficient to meet the significant capital requirements for reconstruction of individual homes and farms, and its distribution was inefficient. Additional support for rebuilding had been promised by the government, but had not yet been distributed when our research took place. Residents expressed doubt that the government would deliver and have relied primarily on international and local NGOs for help, as well as intra-community support and labor exchange for farm reconstruction.

Labor considerations

Labor availability is central to crop cultivation. In the current period of reconstruction, sustained damage to fields and the need to rebuild homes intensifies labor shortages, preventing many farmers from planting as extensively as they did before the earthquake. Lack of an adequate labor force has increased the price for farm hands. Following the earthquake, daily labor wages increased significantly from Rs. 200–300 (\$1.80–2.80 USD) to Rs. 400–500 (\$3.70–4.60 USD) per day for “soft” (female) labor and Rs. 400–500 (\$3.70–4.60 USD) to Rs. 800–1000 (\$7.40–9.30 USD) per day for “hard” (male) labor. Local experts attribute this rise to several factors including pre-existing supply pressures from out-migration. Increased prices of household goods and services due to India’s 2015 oil and gas blockade² have also inflated the costs of labor. Additionally, our interviews revealed that local laborers received monetary aid as part of relief measures, which reduced their need to earn off-farm labor income. Because farms in the mid-hills rely on family and local labor to tend to off-field resources (forests and water) and on-farm crop production and livestock, the feminization of agricultural communities (Tamang et al. 2014) has put increasing pressure on the workload of family members and specifically women and older children.

Through crop calendars and participatory budgeting with lead cardamom growers and other cash crop and subsistence farmers, we explored local perceptions of price variability and compared labor requirements for cultivation of maize, millet, wheat, rice, cardamom, kiwifruit, and

Table 1 Self-reported farmer adoption factors for cash crop options in Dolakha. Data were gathered using participatory budget and crop calendar exercises (where 6 farmers used a relative counting system to rank inputs from lowest to highest), as well as focus groups and semi-structured interviews. The crops listed are considered market-oriented and presented in comparison with the typical subsistence crops of the region (maize, wheat, millet and rice)

	Cardamom	Kiwifruit	Potato	Green vegetables
Cash value	High	High	High	Medium
Labor requirements	Low	Low	Medium	High
Input requirements	Low	Low	Medium	High
Environmental co-benefits ^a	High	Medium	Medium	Low
Capital investment requirements	Medium	High	Low	Low
Length of investment returns	Delayed (3 years)	Delayed (6 years)	Immediate	Immediate

^a By ‘environmental co-benefits’, we refer to the positive effect that a measure aimed at one objective may have on another. Past studies have identified cardamom as “economically valuable, ecologically adaptive, and agro-climatically suitable” (Sharma et al. 2016)

potato (Table 1). When compared with rice, maize, millet, and wheat, household-level participatory budget activities revealed initial labor investments for cardamom (seedling cultivation and field preparation) comparable to subsistence crops. However, after this initial input, much less labor is required to maintain or harvest cardamom.

Farmers perceive labor costs for successive years of cardamom cultivation as dramatically lower than other crops. As one farmer explained, “I can tend to (mature) cardamom by myself; for other crops, I must hire labor”. An older farmer explained how the low labor inputs for cardamom afford more time for reconstructing the family’s home. The economic and labor benefits of cardamom also make sense for the farmer’s son who reported, “I have little education or skills and so I cannot get a good job. Growing cardamom will allow me to make a good income and stay in the village with my family”.

Ecological considerations

Physical changes to the landscape have also influenced decisions to adopt and produce cardamom. In Boch, damages to homes and farms from the earthquake forced some families to temporarily relocate. Residents of one small hamlet below the Lamabagar Road³ moved to community forest-managed land after the May 12th earthquake. “The

² In September 2015, after Nepal’s new constitution was announced, India imposed an ‘unofficial’ or ‘undeclared’ transport blockade. The Indian government claimed that they were not intentionally restricting transportation, rather that Madhesdhi protests at the border prohibited safe movement of goods into Nepal. India supplies nearly all of Nepal’s oil and gas, and this two-month blockade limited their flow into Nepal, resulting in a widespread fuel crisis. This shortage reverberated across the economy, severely impacting sectors from agriculture and disaster relief to tourism and pharmaceuticals.

³ Central, paved thoroughfare that runs east–west across Dolakha District; the main district road for transport of goods.

land we have is not safe”, a farmer and mother reported. With her house completely destroyed and the terraces above significantly damaged, the threat of additional landslides forced her and thirteen other households to abandon their properties. “We are scared to return to our land”, she explained.

In the fields high above the Lamabagar Road in Sundrawati, one farmer explained how his *bari* (rainfed fields; typically used to cultivate maize and millet) suffered extensive damage due to the earthquake. The large cracks and holes will not support the intercropped maize and millet he grew pre-earthquake. “I now plan to grow cardamom in my *bari* instead to stop the landslides that are likely to happen if I continue to plant my previous crops. Cardamom and alder will be safer for my land”, he said. Several water-conscious farmers also noted that when grown together, cardamom and alder conserve and even enhance water sources. Historically, degraded or marginal land was replanted with chir pine (*Pinus roxburghii*). However, alder is a more appealing option as chir pines dominate from ground to canopy, limiting local biodiversity and fodder collection potential and reducing water access downstream due to shallow and water-hungry root systems (Nautiyal 2015). Chir pine plantations are also more prone to forest fires, as needles and other biomass accumulate on the forest floor (Sinha 2002).

Growing cardamom and alder together is additionally attractive as cardamom plants can be used in papermaking industries and alder can be felled as a timber product. One such paper production site already exists in Dolakha. Secondary product potential, alongside the need for additional income, prompted a new farming strategy for the entire relocated hamlet to plant cardamom. One young farmer planted 100 seedlings purchased from the local agricultural office in the season following the earthquake and will plant 100 more in the 2016 season. She anticipates the new crops will stabilize the fields, require little labor and provide good returns, thus retaining the production value of her property and limiting her exposure to dangerous landslide-prone areas. Moreover, as the sole caretaker of her farm, the lower labor requirements of cardamom address rising shortages and costs of hired field labor as well as her husband’s absence as a laborer abroad.

These vignettes highlight how multiple influences and impacts of the earthquake become key variables in farmer’s decision-making and act alongside existing and ongoing drivers of agricultural transition (Fig. 3). The need for cash to rebuild after the earthquake has strained farming systems and challenged the viability of subsistence mountain livelihoods. As a result, farmers have gradually introduced high-value crops and other entrepreneurial activities to diversify and increase income, reduce labor costs and bolster economic security. The transition to cash crops is

long-standing in these mid-hills communities; however, in the post-disaster context, cardamom has become more economically and ecologically appealing compared with other cash crop options. This adoption pattern demonstrates how disasters can become critical moments for accelerating ongoing agricultural transition pathways.

Potential risks from cardamom adoption

Cash crop adoption requires careful consideration of ecological conditions and interactions. In Dolakha, participants consistently noted uneven and increasingly unreliable access to water due to warmer seasons and environmental shocks, such as landslides. Although cardamom requires less water than many subsistence crops, moist soil environments are essential. Climate change is a critical factor in explaining increasing uncertainty in water sources, as exemplified by the drought that followed the 2015 earthquakes. Additionally, it is well-known that viral and fungal diseases reduced cardamom production in eastern Nepal (Takahamake 2001; Chaudary and Vista 2015). Though not yet identified in our study locations in Dolakha, some farmers suspect disease may be the cause of recent productivity declines. Testing for a cultivar resistant to the disease is currently underway (MoAD 2015); however, interviews in Dolakha reveal that information regarding disease mitigation is not well-distributed throughout the district. As one farmer admitted, “I think the disease may be affecting my fruit, but I’m not sure what I can do about it”.

DISCUSSION: CHALLENGES OF ADOPTION

Rebuilding the agricultural sector is a top priority in periods of recovery and reconstruction, and cardamom has become an important component of campaigns for poverty reduction and disaster risk reduction (National Planning Commission 2015). Prior to the earthquake, in the eastern district of Ramechhap where cardamom is extensively produced, the UN Development Programme’s Rapid Enterprise and Livelihood Recovery Project lauded: “ever since they [local villagers] started farming this spicy plant in their least yielding fields, the monster of poverty has gone away. Perhaps, forever.” However, such plans are often implemented in communities with connections to roads and markets or where a niche crop can be cultivated (Brown and Kennedy 2005). This can be seen in earthquake reconstruction plans where, for example, local value chains have been identified for high-value crops, including cardamom. Such plans aim to expand economic opportunity and bolster recovery by promotion of crops that can be grown in earthquake-impacted areas and processed in the *Terai* (lowland plains) (Randolph and Agarwal 2017).

Fig. 3 Analytical framework of ongoing and post-disaster factors impacting high-value crop adoption in the mid-hills of Nepal. Arrows indicate relationships between patterns that emerged from our empirical findings. These affect ongoing changes and interact with community-level impacts from the earthquake to motivate particular crop decisions. For example, decreased access to farm labor due to out-migration converged with loss of critical livestock support and manual labor for hire, leading to desire for low labor crops; whereas damage to fields and uncertainty in water sources limited farmer capacity to plant traditional crops, like rice, which require stable terraces and reliable irrigation. The earthquake further undermined the structural integrity of many terraced slopes and fields, resulting in increased landslide risk, leading to a need for crops that stabilize or grow on marginal lands, like cardamom

Despite the ability of cardamom to address multiple post-earthquake stresses, our findings reveal that cardamom interventions face limitations. First, starting cardamom production requires appropriate land and new plantings can take at least 3 years to reach maturation. For many of the most impoverished farmers, land is limited, or highly restricted to sharecropping contracts. In the past, cash crop cultivation has conflicted with more traditional communal land management practices. Protests and local conflict erupted in Sundrawati several years ago after some residents attempted to grow cardamom in community forests. Post-earthquake, some community forestry groups began to allow landless farmers to grow cardamom in the forest; sharecropped land is currently reserved for subsistence crops.

Access to cardamom is also differentiated by geography, such that communities like Charikot (the district capital and an urban center) and Boch (located on a major thoroughfare) have better access to nearby agricultural offices that offer seedling discounts and technical support. Several cardamom farmers in Boch regularly attended trainings and received support from the agricultural offices, while others in the more remote Sundrawati had little interaction with agricultural technicians. This is likely because the country's one Tropical Fruits Rootstock Development Center (TFRDC) is located in Boch, which is a multi-hour bus ride from Sundrawati. For more distant villages without active

Fig. 4 Cardamom seedlings ready for distribution at the District Agricultural Development Office (DADO) in Charikot, Dolakha District, Nepal

agricultural offices, traveling to the district center of Charikot can be time-consuming and expensive. Despite significant interest in adopting cardamom in Sundrawati, some farmers felt they lived too far from the DAO in Charikot or TFRDC in Boch to regularly and reliably access available support and resources. As one farmer in Sundrawati explained, “if you don’t happen to be at the office on the day they are distributing seeds, you don’t get any seeds or seedlings” (Fig. 4). Unlike regions in eastern

Nepal, farmer-to-farmer extension of cardamom was not widespread in Dolakha.

Other barriers to participation that exist across many development programs, like access to information or grant-writing ability, are relevant in our study communities. For example, existing NGO- and government-support programs, like the High Mountain Agribusiness and Livelihood Improvement (HIMALI) Project, offer grants for the materials needed to start growing high-value crops. A kiwifruit farmer we visited in Dolakha received such a grant for the poles he needed to construct the supports for the kiwifruit plants. However, he explained these programs often require a written application and the ability to compose a compelling grant application. Additionally, the farmer may be asked to demonstrate grant-matching capacity. Many who apply hire a person in the district capital who knows how to write and format the application. Even with grant support, capital inputs like seedlings or soil amendments may be out of reach for smallholder farmers. These requirements, thus, restrict cardamom adoption to Dolakha's better off smallholder households, who have the capacity to invest and wait for the plant to produce. Consequently, differentiated participation in post-earthquake adoption of cash crops, including cardamom, may accentuate pre-existing social inequality, as existing programs to increase its production lift up the already more resourced farmers, as opposed to poorest producers.

Farmers in Nepal with access to enough capital to plant cardamom are exposed to a broader and more complex supply chain than their subsistence-dominated systems. In much of the global South, decisions to cultivate high-value crops are often constrained by market demand (Patel 2008), whereas rice, millet, wheat, and maize are consumed at home or traded with neighbors. Nepal's cardamom market is predominantly international. Conventional economic logic contends that market competition from India and Bhutan may lead to future market saturation and depressed prices. However, despite existing knowledge of these trends, leaders of cardamom cultivation associations showed little apprehension about these macroeconomic factors and international production dynamics. They instead insist that "cardamom will provide more stability and higher income than rice or wheat because demand in India and the Middle East is only increasing".

For farmers in remote villages, information regarding price and distribution is limited. A study on cardamom farming in Hmong communities in Vietnam highlights the importance of market knowledge and social networks, and how without them certain actors disproportionately profit (Turner 2017). Similarly in Dolakha, limited information constrains farmer choices. Non-local cardamom dealers negotiate the supply chain and collect the cardamom seeds, while the Indian market typically sets prices. Farmers we

interviewed reported making Rs. 1800–2600/kg (\$16.70–18.40 USD/kg), while the end market retail price is closer to Rs. 5500/kg (\$50.00 USD/kg). This broadly follows patterns where power is concentrated in the hands of agribusiness brokers rather than farmers (Patel 2008), thus allowing intermediaries to collect product at low farm gate prices. The creation of storage mechanisms and value addition activities could improve profits for farmers in Dolakha; however, interviews revealed limited farmer capacity for such activities.

Cardamom offers clear benefits for some farmers devastated by the earthquakes and responds to the labor shortage and cash needs of households, as they struggle to rebuild their lives and farms. However, unevenly distributed interventions and benefits, coupled with high capital costs of transition and cultivation, may lead to increased rural differentiation and exacerbate inequities in local communities. Furthermore, it may not address concerns associated with food security. With this, along with potential risks of disease, downward price pressure and market saturation in mind, the capacity for cardamom to extend comprehensively across populations in the mid-hills is limited. Cardamom and its associated land, information, technical and capital requirements, thus make this transition one available to a limited group of farmers.

CONCLUSION

This paper underscores the capacity of disasters to interact with agricultural and socio-economic systems in ways that accelerate adoption of specific crops, and potentially contribute to further social differentiation. We examined ongoing crop transition in the mid-hills of Nepal in the context of the 2015 earthquakes. While crop transition is widespread, adoption of individual crops responds to particular cultivation requirements and market pressures. Farmers choose cardamom within the context of rising cash crop economies, out-migration, climate change and agriculture policy. Threats from landslides, damaged fields, post-earthquake labor shortages, changed water sources and immediate cash needs for rebuilding were additional motivations for cardamom adoption in the post-earthquake landscape. These motivations highlight how environmental shocks alongside specific crop features create new interactions between economic and environmental variables. Although attractive for enhancing income and livelihoods in rural mountain communities, and an option with keen ecological benefits, widespread cardamom cultivation is not without challenges. Adopting high-value and low labor crops may allow farmers to more readily adapt to pressures from out-migration, feminization of the labor force or recovery from environmental shocks. Yet,

inequitable distribution of land, capital, government support and information favor cardamom adoption by better off smallholders, which could exacerbate rural differentiation. Moreover, growing cardamom may introduce new risks involving food security, volatile international markets and unpredictable diseases for farmers already adapting to a post-disaster scenario. This means that not every farmer can nor should choose cardamom. As Nepal faces continued risks from environmental disasters alongside and interacting with ongoing agricultural transitions from subsistence to high-value crops, further research is needed to understand the complexities of adaptation choices and their implications for social differentiation, and to identify options for more targeted and equitable agricultural support.

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AUTHOR BIOGRAPHIES

Jessica DiCarlo (✉) is a doctoral student in the Department of Geography at the University of Colorado Boulder. She earned her M.A. in Development Studies at the University of California

Berkeley, and B.A. in Political Science and International Studies from Pepperdine University. Her doctoral research examines the grounded implications of Chinese infrastructure projects in relation to wider hegemonic projects of development.

Address: Department of Geography, University of Colorado Boulder, 110 Guggenheim Building, Boulder, CO 80301, USA.

e-mail: jessica.dicarlo@colorado.edu

Kathleen Epstein is a doctoral student in the Department of Earth Sciences at Montana State University with the Resources and Communities Research Group. She earned an M.S. with the Energy and Resources Group at UC Berkeley, and has a B.A. in Anthropology from Davidson College. Her current doctoral research explores how changing land tenure patterns in the Greater Yellowstone Ecosystem impact the capacities and policies of wildlife management.

Address: Department of Earth Sciences, Montana State University, 221 Traphagen, Bozeman, MT 59718-4001, USA.

e-mail: kathleenepstein@montana.edu

Robin Marsh is an agricultural socio-economist and senior researcher at the Institute for the Study of Societal Issues at the University of California, Berkeley. Marsh received her Ph.D. from the Food Research Institute, Stanford University. She has over 25 years of experience in international agriculture and rural development. Marsh conducts collaborative research on the nexus of gender, agriculture and natural resource management. She is a Senior Fellow with the NGO Ecoagriculture Partners and an Affiliate Faculty member with the Berkeley Food Institute.

Address: Institute for Study of Societal Issues, University of California Berkeley, 2428 Bowditch Street, Berkeley, CA 94704, USA.

e-mail: robinmarsh@berkeley.edu

Inger Måren is an associate professor at the Department of Biological Sciences, University of Bergen (UiB), Norway. She has a minor in social anthropology, a Master's in plant ecology and a Ph.D. in quantitative ecology. Her work focuses on effects of anthropogenic disturbances created by diversified farming practices in the global north and south on ecosystem function, vegetation patterns and biodiversity. She has worked in Nepal over the last 20 years, giving her a comparative, global perspective to the interactions between agroecological systems, the environment and human impacts.

Address: Department of Biological Sciences, University of Bergen, Thormøhlensgt 53A, 5007 Bergen, Norway.

e-mail: inger.maaren@uib.no