



Addressing food and nutrition insecurity in the Caribbean through domestic smallholder farming system innovation

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Abstract Smallholder farmers are key actors in addressing the food and nutrition insecurity challenges facing the Caribbean Community (CARICOM), while also minimizing the ecological footprint of food production systems. However, fostering innovation in the region's smallholder farming systems will require more decentralized, adaptive, and heterogeneous institutional structures and approaches than presently exist. In this paper, we review the conditions that have been undermining sustainable food and nutrition security in the Caribbean, focusing on issues of history, economy, and innovation. Building on this discussion, we then argue for a different approach to agricultural development in the Small Island Developing States of the CARICOM that draws primarily on socioecological resilience and agricultural innovation systems frameworks. Research needs are subsequently identified, including the need to better understand how social capital can facilitate adaptive capacity in diverse smallholder farming contexts; how formal and informal institutions interact in domestic agriculture and food systems to affect collaboration, co-learning, and collective action; how social actors might better play bridging and

linking roles that can support mutual learning, collaboration, and reciprocal knowledge flows; and the reasons underlying past innovation failures and successes to facilitate organizational learning.

Keywords Community-based development · Land use policy · Food policy · Complexity · Sustainable food systems

Introduction

Formally recognized at the Earth Summit in 1992, Small Island Developing States (SIDS) confront a range of context-specific challenges (Angelucci and Conforti 2010) while also sharing common challenges related to small size, insularity, remoteness, geographic isolation, and proneness to natural disasters (Briguglio 1995). Annual climatic variability and intensification of extreme weather events associated with global environmental change are adding more layers of complexity to the sustainable development of many SIDS (Blancard and Hoarau 2013; Tompkins and Adger 2004).

The Caribbean Community (CARICOM) represents an economic grouping of fifteen nations, primarily SIDS (Fig. 1). The SIDS of CARICOM have long been identified as being vulnerable to environmental change due to their small size, exposure to natural hazards, limited natural resources, and ecological uniqueness (Blancard and Hoarau 2013; Méheux et al. 2007). Although these states face a wide range of socioecological vulnerabilities, their unique characteristics have made them highly desirable tourist destinations (Armstrong and Read 2002; Read 2004). Beyond seasonal tourism, the natural resource sector also forms a significant component of many national economies

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Fig. 1 Map of the Caribbean Community (CARICOM)



in the CARICOM, with agriculture playing a particularly important role in supporting rural livelihoods. Smallholder farms, defined as farmers with limited resources operating on less than two hectares (World Bank 2003), comprise nearly 90 % of the farms that operate in the CARICOM (Fig. 2a) and account for approximately 55 % of the total farm land (FAO 2012) (Fig. 2b). These often informal farming systems face a wide range of systemic challenges to sustainable food production that include low levels of technology, the absence of barriers to market entry, difficulties in group coordination, asymmetry in the flow of knowledge and information, and high degrees of exposure to natural shocks (Birner and Resnick 2010; Dorward and Kydd 2004; Kydd and Dorward 2004), limiting their ability to compete in domestic markets flooded with imported food (Clegg and Shaw 2002; FAO 2012; Gumbs 1981).

Historically, CARICOM countries based their economic development planning on the export of plantation cash crops to preferential markets in Europe (Axline 1986; Watts 1990). This agriculture-led economic development strategy resulted in agricultural institutions that were heavily directed toward export markets rather than the needs of domestic food markets. Both smallholder and larger-scale producers in the region were vertically integrated into value chains with coordination being managed through “top-down” formal institutions (Thomas 1988). While export cash-crops generated significant short-term economic benefits, the loss of protected markets due to

globalization and trade liberalization led to a dramatic decline in agricultural production across the region (Deep Ford et al. 2007). According to Andreatta (1998), the heavy focus on export markets fostered cyclical vulnerabilities in smallholder farming systems across the region, mainly due to an overexposure to exogenous shocks (Armstrong and Read 2002; Read 2004) driven by competition from low-cost producers benefitting from economies of scale, volatility in customary markets, and unsteady foreign exchange rates (Andreatta 1998). Over the period 1986–2006, dramatic changes occurred in the agriculture sectors across the region with CARICOM’s share of global agricultural exports falling from 2 to 0.3 % and the value of net agricultural exports changed from a surplus of US\$ 2.9 billion to a deficit of US\$ 2.2 billion over the same period (CARICOM 2007). In concert with the decline in export agriculture, CARICOM populations have been experiencing increasing rates of non-communicable diseases (NCDs), particularly obesity and overweight (CARICOM 2010) among women (Fig. 3) and children, raising serious domestic and international public health concerns (World Bank 2011). These health trends have been associated with an increasing dependence on the imported energy-dense foods, consumer food choices that have led to low consumption of fresh vegetables and fruits and sedentary lifestyles (Samuels et al. 2012).

One strategy adopted by the CARICOM Secretariat to address these regional challenges has been to try and realign domestic agricultural production with a view to

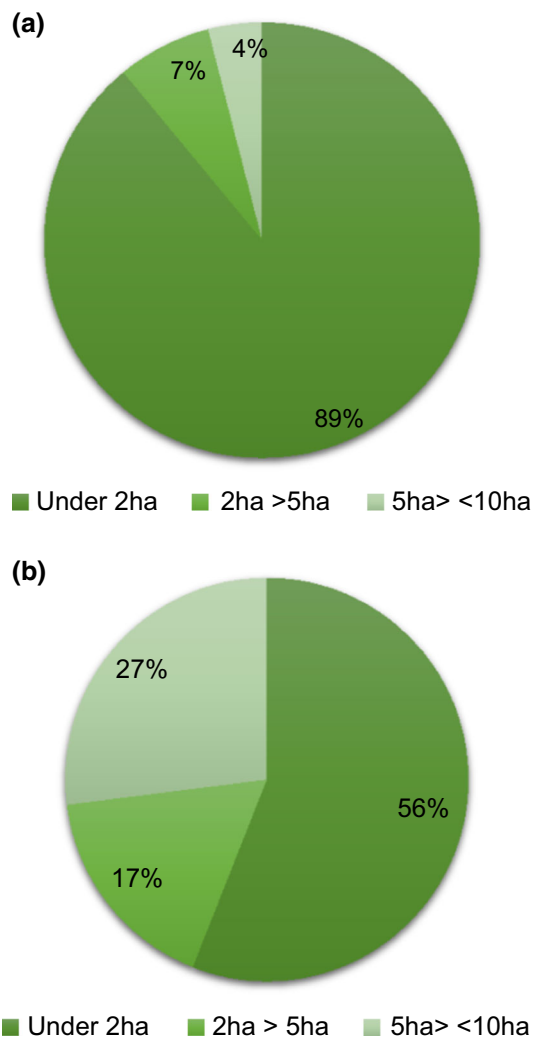


Fig. 2 a Proportion of farms by size (a) and b proportion of agricultural land area by farm size in the CARICOM. Data source FAO (2012)

enhancing dietary diversity and quality (Brathwaite and YongGong 2012; CARICOM 2010). However, realizing such a vision will require a fundamental departure from past institutional approaches (sectoral, state-led, or market-led) in order to better account for the complexity of the local agriculture-food systems and support the multi-level innovation processes required to ensure the resilience of domestic food systems. Recognizing the significance of the challenges that face the region, this paper reviews how institutional arrangements in Caribbean agriculture and food systems have been driving smallholder vulnerability in a cyclical manner. We first describe the conditions that have been undermining sustainable domestic food production in the region, focusing on issues of history, economy, and innovation. Building on this discussion, we argue for a different approach to agricultural development in the SIDS of the CARICOM that draws primarily on

socioecological resilience (SES) and agricultural innovation systems (AIS) frameworks. Working within this approach, we then discuss potential policy options and identify research needs.

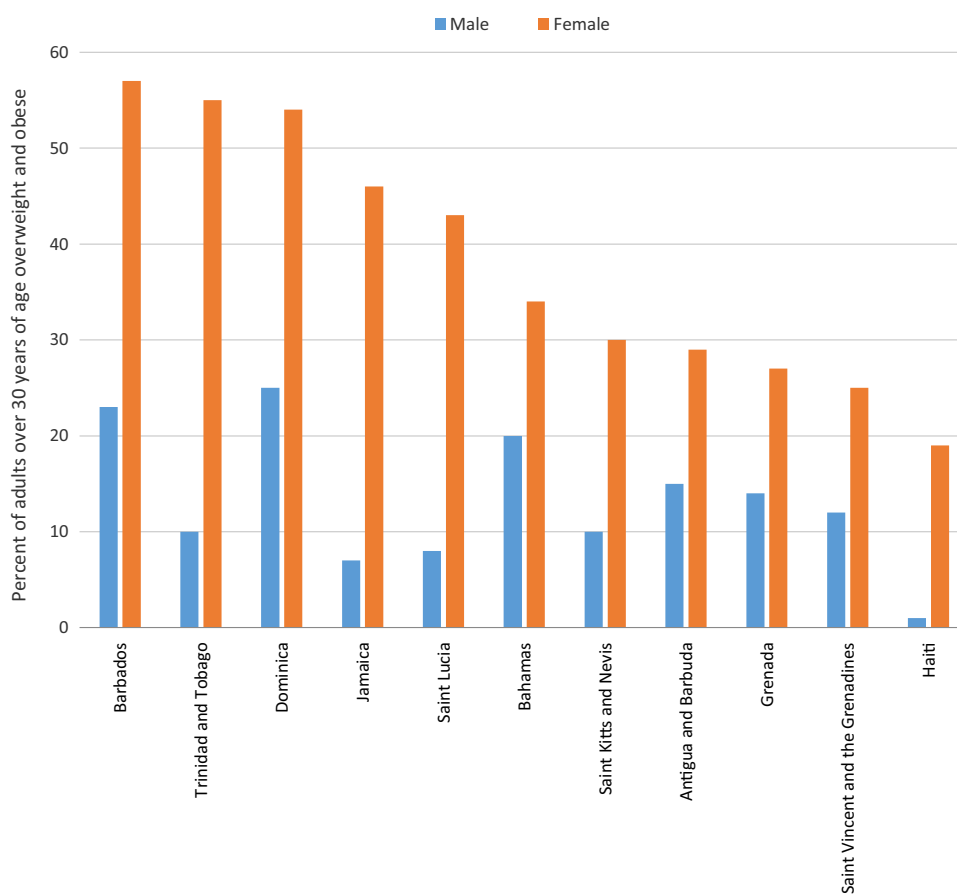
Conditions undermining domestic agriculture and food systems in CARICOM SIDS

History: plantation institutions and the legacies of colonization

The legacies of colonization in the Caribbean have been the subject of much study, influenced by Frank's (1969) analyses of economic development and external structural arrangements (Beckford 1999; Cooper et al. 1993; Lewis 1968; O'Loughlin 1968; Richardson 1992a; Thomas 1988). Increasingly, however, it is being recognized that domestic institutions in ex-colonies have the potential to play a significant role in sustainable and equitable economic development (Acemoglu et al. 2002; Favaro 2006; Mendola 2007; Olson 1996; Rodrik et al. 2004; Seligson and Passé-Smith 2008). In the context of agricultural development, understanding how colonial institutional legacies have fostered export production in the SIDS of the CARICOM region requires examination of the role played by domestic policy and institutions (Rodrik et al. 2004; Seligson and Passé-Smith 2008). Recognizing this, Timms (2008) traced agricultural policy development in the Caribbean from the colonial mercantilist interests (1500–1900) to the most recent 2008 food price hikes and offered three factors driving CARICOM's export-oriented focus: (1) in-country resistance to changing the status quo by the planter class and political elites; (2) lack of resources to support institutional change, first by colonial and then ex-colonial powers who have been concerned primarily with their own positive balance of trade and utilizing aid to sustain such terms of trade; and (3) most recently, neoliberal trade policies that have disadvantaged small local producers through market flooding with cheaper food produced in industrial agricultural systems (see also Elliott and Palmer 2008).

Across the Caribbean, the "plantation" as an institution of political colonization was both a powerful economic and social unit, surviving for over 450 years with minimal structural change (Beckford 1999; Beckles and Shepherd 1996), and influencing social norms, interactions, and relations concerning agriculture. Caribbean plantation agriculture was a system informed by an exploitation and domination ethic that used land and labor for the maximum extraction of profit. More specifically, Richardson (1992a) identified six characteristics of the Caribbean plantation institution: (1) viewing land as a commodity, (2) complete

Fig. 3 Prevalence of overweight and obesity in the Caribbean population >30 years old. *Data source* Deep Ford 2013



control of resources and their use centralized by the owner or representative, (3) significant investment in equipment and technology for monocrop agriculture, (4) introduced workforce controlled by coercion and/or force (slavery), (5) production oriented toward foreign mass markets, and (6) supporting policies devised by foreign capital interests. Other linked norms associated with the plantation institution include racist and exploitative ideologies that have affected human relations in the Caribbean agricultural system (Beckles and Shepherd 1996). For example, Thomas (1988) described plantation relations during slavery as authoritarian, based on force, terror, fear, and fraud (see also Richardson 1992a). In order to supplement imported food rations, each slave was allowed 1 day a week to tend to their garden and exchange surplus produce. As a result, producing food for subsistence was one of the few areas where slaves were able to enjoy the fruits of their labor and subsistence farming became the focal point of family and community life (Thomasson 1994). According to Mintz and Price (1976), these interactions form the basis of the contemporary informal institutions that support domestic production and weekly farmer markets in the Caribbean (Richardson 1992a).

After emancipation of slavery in 1838, slaves were freed and their legal status changed, however, their economic domination by planters remained a societal norm (Thomas 1988). For sugar, the major export crop at that time, prices fell and the region experienced economic depression, leading ex-slaves to riot against oppression and causing widespread social unrest (Watts 1990). The British colonial administration responded to the situation with the West India Royal Commission of 1897, hailed as the “Magna Carta of the West Indian peasant” (Shephard 1947 p. 63), designed to deal with concerns of declining revenue from sugar production, lowering of wages, and the abandonment of plantations by freed slaves. The commission made five major recommendations: (1) settlement of peasants on small plots of land; (2) establishment of small-scale agricultural industries; (3) improvements in regional communications; (4) development of a fruit trade; and (5) establishment of cane-milling factories (Richardson 1992a; Richardson 1992b). Recognizing the highly charged conditions in the colonies, the administration moved to implement non-revolutionary changes. Land settlements were initiated to pacify landless peasants, and the development of the fruit trade was initiated, transitioning much of the region from sugar to banana production (Axline 1986;

Clegg and Shaw 2002). Initially, plantation owners often blocked land settlement schemes, assuming that they would increase labor shortages and negatively impact their production (Thomas 1988). As a result, the ownership of land and the exchange of labor in the CARICOM region became subject to societal class divisions that still pervade the society, particularly in the agricultural sector (Thomas 1988), and would serve to limit the proper functioning of market or economic forces. Lamming (1981) described how these tensions impact labour availability in the region:

[A]t the deepest levels of a man's being it cannot make sense that he should ... labour for those whose style of thinking discloses them to be his enemies (Louis 1981 p. 222).

Eventually, under pressure from ex-slaves, land settlement schemes were implemented but they did not generate the desired outcomes. Five factors can be seen as undermining these settlement plans: (1) political expediency—lands were carved into farms of less than two hectares to increase land ownership levels among many peasants rather than into more economically viable units; (2) low access to financial and physical capital and technology which kept production levels low; (3) low levels of human and social capital with many farmers lacking the knowledge to design and sustain commercial operations; (4) lack of natural capital—since plantations were already located on the fertile lands and plains, smallholders were often allocated inappropriate and marginal lands which limited production and increased land degradation; and (5) local elites, with conflicting economic interests in the wholesale business of food imports, actively undermined agricultural investments directed toward domestic production and local markets (Axline 1986; Timms 2008).

[T]he peasants of the Caribbean have been embattled since their beginnings agricultural or infrastructural improvement—in roadways, marketing facilities, agricultural extension and credit, crop varieties...went to the plantation sector.... Perhaps the most unusual thing about Caribbean peasantries is that any of them survived at all (Mintz 1985 p. 132).

Beyond the formal land settlement schemes, land tenure across the CARICOM region also became subject to a diverse range of informal, unclear, and complex (multiple ownership) arrangements. For example, communal, indigenous, and generational land ownership is still found in Suriname, Belize, Jamaica, Bahamas, Tobago, Dominica, and Saint Lucia (FAO 2013). In Saint Lucia, 45 % of all land parcels fall under the generational “family land” title, defined as lands owned across generations of a family that can be accessed and used by a multiplicity of heirs without title by virtue of shared bloodline (OAS 1986).

These sociohistorical influences on land and labor continue to pervade agriculture in the region. Further, the relative ease of access (not ownership) to small, sub-economic farm units serves to limit the operation of the more conventional microeconomic principles needed to support conventional commercial agricultural investment and development.

Economy: small size of domestic markets

The small size of domestic markets and the absence of economies of scale present a particular challenge to sustainable domestic agricultural sector development and regional food security for the SIDS of CARICOM. According to Blancard and Hoarau (2013), small domestic markets, absence of economies of scale, limited economic diversification, high costs of imports, and limited private sector development are significant challenges to innovation in most sectors. In the agricultural sector, these challenges are compounded by limited natural resources, remoteness and insularity, and vulnerability to natural disasters, which further undermine the resilience of domestic food systems. According to Briguglio (2003), the factors affecting development capacity and innovation in the small market economies of CARICOM include: (1) loss of high-skilled human capital (“brain drain”) with 70 % of the regional labor force migrating to developed economies (Mishra 2006; Stubbs and Reyes 2004); (2) high social cohesion among policymakers and social elites which stifles growth (Briguglio 1995); and (3) revenue shortfalls from the small population and taxation base resulting in public service limitations (Briguglio 1995; Favaro 2006). These are significant size-related challenges which limit the options and resources available to decision makers tasked with developing and reviewing the effectiveness of existing institutional arrangements (Tonurist 2010).

Notwithstanding historical legacies, institutional “lock-in,” and size-related limitations, the governments of CARICOM have recognized the urgent need to foster innovation across their domestic agriculture-food systems to help build the adaptive capacity of rural communities and address the growing public health crises of NCDs, resulting from low dietary and nutritional diversity (CARICOM 2010). The complex challenges of food insecurity became further highlighted during the 2007–2008 food price hikes (Grote 2014), which revealed that while there had been extensive investments in agricultural science and technological developments, there had not been matching policy innovation around the institutional arrangements that support smallholder farmer systems (FAO 2013; Gamble et al. 2010; von Braun 2009). According to Maetz et al. (2011), many governments have returned to previously neglected areas of food security-related public policy since the

2007–2008 food price hikes due to a lack of confidence in the market, unwillingness of policymakers to continue dependence on the private sector to provide signals for food security decision-making, and attempts to make policy more context-driven. Their analysis of the policy options implemented by CARICOM SIDS revealed that 42 % had initiated producer-oriented measures (e.g., input subsidies, seed improvement, and input price control), 17 % trade policy measures (e.g., food imports/exports imposed or lifted), and 25 % consumer-oriented measures (e.g., school feeding, price control, and removal of VAT) (Maetz et al. 2011). As the CARICOM searches for new, context-driven food and nutrition security policy options, the region will require a better understanding of how existing (often informal) domestic institutions function and how they can and do inform formal agricultural sector reform policy and process.

Institutions, interactions, and innovation: lack of formal learning and low levels of adaptive capacity

Another significant challenge facing the agriculture and food sectors in the CARICOM is the malfunctioning of institutions, namely: (1) a lack of interaction and interdependency between institutions that support learning and (2) the absence of enabling cultural environments (Lederman et al. 2013). It is, therefore, important to understand how interactions between actors and institutions (i.e., common rules and procedures) in the agriculture-food system function in order to promote resilience and adaptive capacity through innovation, co-learning, and collaboration (Bahadur et al. 2013; Dessie et al. 2013). Importantly, institutions are central in helping (or hindering) social actors in the food system to: (1) absorb change and maintain function (buffer capacity); (2) self-organize; and (3) enhance learning (Speranza 2013). In order to better understand how institutions have affected the agricultural production systems operating in the CARICOM, we depict the interactions between networks of organizations and actors together with the dominant institutions and policies (Fig. 4) to show how interactions between agriculture and food-related institutions have helped and hampered smallholder farmers absorb change, self-organize, and learn through time. Figure 4 shows that since the 1900s, minimal institutional change has occurred in the functioning of the region's two-tiered agriculture-food system, with human, social, economic, and institutional resources directed primarily toward commodity-oriented production. When comparing how the commodity-oriented export production and domestic-oriented subsistence production have helped social actors absorb changes, organize, and learn, we can distill three main differences. First, they have different worldviews and approaches to change. In the CARICOM, a

command and control paradigm (evolving from the plantation institution) has informed the formal agriculture and food institutions of government (Pant 2013). This production paradigm is based on assumptions that include a stable environment where resource flows can be controlled and nature will return to equilibrium (Wilby and Dessai 2010). In contrast, the informal agriculture-food institutions supporting production for the domestic market evolved largely organically, as diverse producers met weekly, exchanged (bartered) and later sold excess production (small volumes) of a wide variety of crops. Second, each production system fostered different social relations, levels of farmer organization, and learning. Social relations from slavery to present created and maintained division between races and classes with low knowledge flows across the class divide. After the emancipation of slaves and later as part of national independence activities, land settlement schemes enabled first ex-slaves and later smallholder farmers to become vertically integrated into export-oriented commodity production programs (Brierley 1974; Brierley 1988; Grossman 1998). These smallholder farmers received significant economic benefits from this approach until the late 1990s, ending with changes in global trading agreements. Over the same period, a smaller group of smallholder farmers oriented toward domestic markets was squeezed into a small niche initially limited to ad hoc production for weekly provision markets (Levitt and Best 1975). While export producers were vertically integrated with linear exchanges of codified knowledge, contrastingly, weekly provision markets developed and organized in a decentralized manner, through what Hart (2005) p. 10 characterized as “the self-organized energies of people excluded by the exigencies of state rule.” In this case, knowledge exchange was more multi-functional and needs based, with social learning and relationships guiding tacit knowledge exchange.

The evolution of a two-tiered agriculture-food system in the CARICOM has resulted in institutional mismatch that likely drives smallholder vulnerabilities, supports institutional inertia in Caribbean agriculture, also provides an entry point for future interventions to enhance innovation outcomes and overall food and nutrition security in the region. Major differences between the tiers include: knowledge types (tacit vs. codified), ethics (subsistence vs. exploitation), knowledge exchange/learning pathways (social learning vs. top-down), production principles (agroecological vs. monoculture), management type (self-emergent vs. authoritarian), institutional forms (informal/flexible vs. formal/command and control), major resource used (social capital vs. financial capital), coordination mechanism (heterogeneous vs. homogenous), and governance (decentralized/multi-level vs. centralized/bureaucratic). Interestingly, both production tiers appear to have

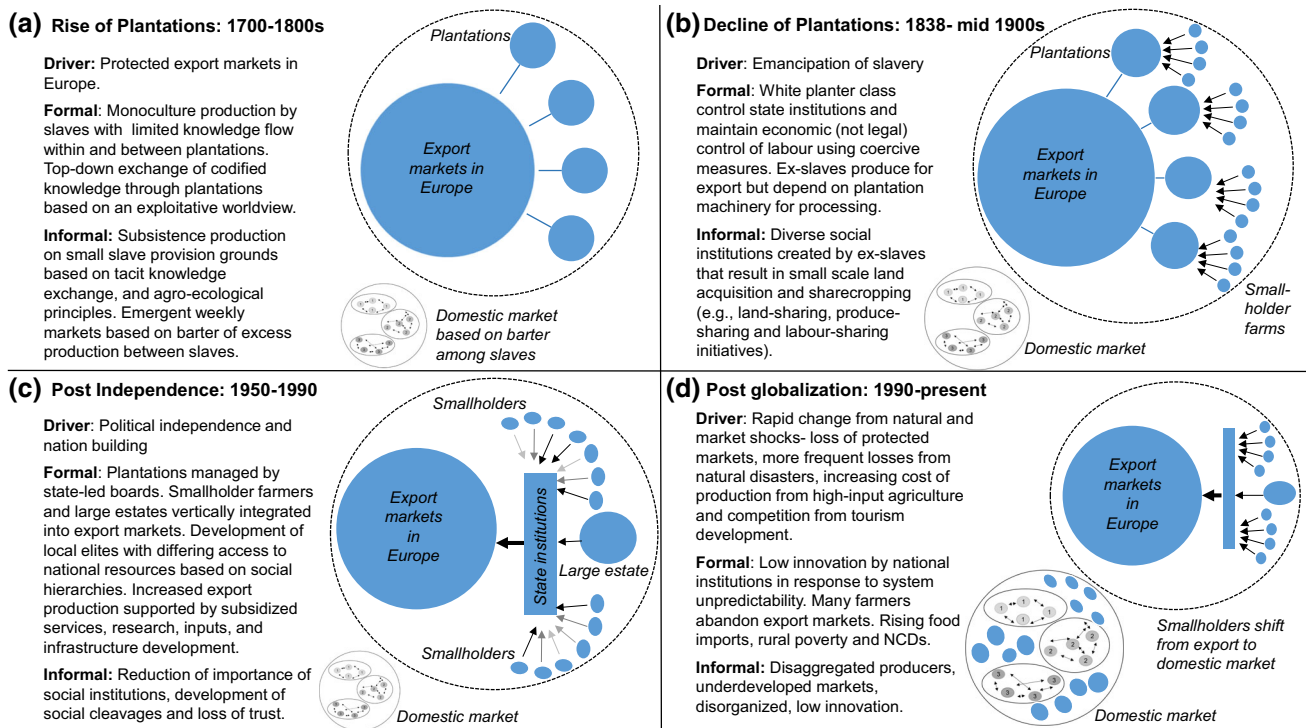


Fig. 4 Structural conditions underlying the development of CARICOM's two-tiered agricultural innovation system (drawing on the history of the English-speaking Caribbean). Sections a–d depict

diverse drivers of change over time, juxtaposed against the institutional inertia of export-oriented formal institutions and the neglect of informal domestic markets

followed parallel processes, with the formal agriculture-related institutions likely undermining the adaptive capacities of smallholder farmers. Rahman et al. (2014) described this phenomenon of dual resource management systems with conflicting objectives as resulting in an “inter-institutional pitfall” which undermines reciprocity, knowledge exchange, learning, and development of common interests across institutions. Policy can bridge these gaps, foster trust, and shared vision by acknowledging informal institutions and enhancing cooperation through inter-institutional processes (such as multi-stakeholder groups) supported by mediating agents (Rahman et al. 2014).

Promoting innovation in the domestic agriculture and food systems of CARICOM

Recognizing the complex challenges that face the CARICOM as it seeks to sustainably develop domestic agriculture-food systems, there is an urgent need for more system-based approaches to policy, practice, and research. More specifically, the historical, economic, and institutional challenges facing smallholder agriculture will require a greater focus on building AIS, defined by (Hall et al. 2006) as “networks of organizations or actors,

together with the institutions and policies” that influence innovation processes and outcomes through interactive learning that results in “new products, new processes, and new forms of organization” (p. 12). AIS thinking goes beyond previous approaches in the region, such as the National Agricultural Research Systems (NARS) and the Agricultural Knowledge and Information Systems (AKIS), to focus explicitly on interactions between actors and their institutional and policy contexts with a view to creating enabling environments for innovation (Klerkx et al. 2012). Understanding how such interactions, interdependencies, and cultural environments developed within CARICOM's AIS offers a potentially fruitful avenue to address the institutional mismatches that likely drive smallholder vulnerabilities and institutional inertia in Caribbean agriculture with a view to enhancing innovation outcomes and overall food and nutrition security in the CARICOM (see Maat (2007) on AIS application in the Dutch Caribbean Island dependencies and Chave et al. (2012) on the French Caribbean Island dependencies). Adopting an AIS perspective also has implications for the ways in which donor agencies, governments, non-governmental organizations, scientists, and communities might best approach resiliency-focused food security policy and research in the region (Bernard and Spielman 2009; Hounkonnou et al. 2012; Schut et al. 2015; Totin et al. 2012).

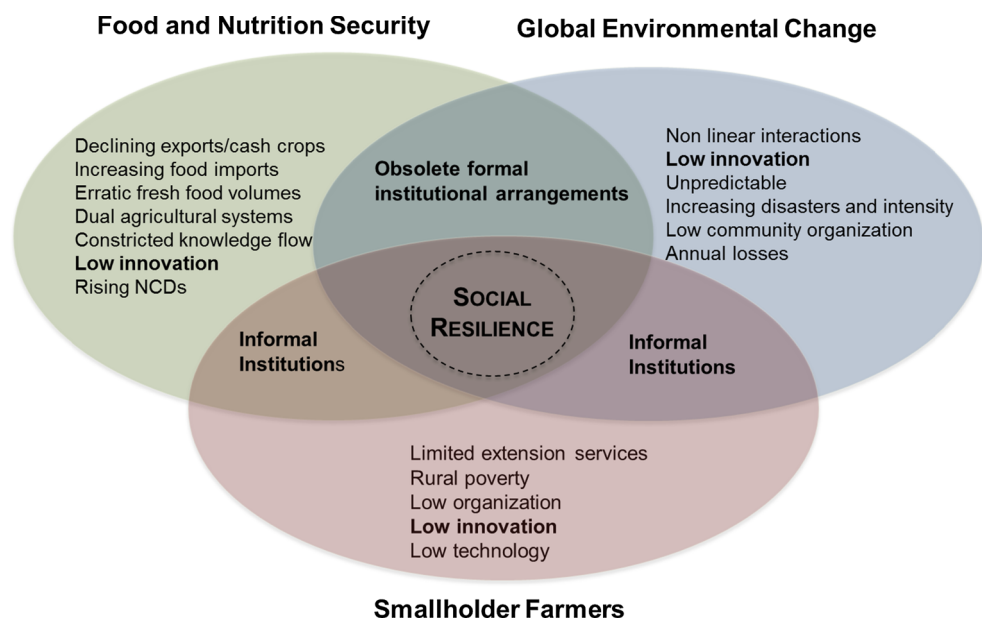
Another important approach to understanding the complexity of the interactions occurring between the human and natural systems supporting agriculture and food systems in the CARICOM is socioecological systems (SESs) thinking (Berkes and Folke 1998). SES thinking views human systems and ecosystems as coupled and emphasizes complexity, feedbacks, systemic interactions, and adaptive capacity (Foran et al. 2014). Efforts to better understand the dynamics of SESs, including how they adapt, absorb shock, and maintain key functions, have revealed important insights to the relationship between institutions and resilience (Folke 2006). More specifically, the concept of social resilience, defined by Adger (2000) as the capacity of groups or communities to adapt in the face of external social, political, or environmental stresses and disturbances, represents an often untapped resource for facilitating SES through adaptation and innovation (Folke et al. 2003; Folke et al. 2005; Pretty 2003; Pretty and Ward 2001). Recently, however, Fabinyi et al. (2014) identified the need to focus further on how social diversity, power relations, and agency affect SESs. For example, Westley et al. (2013) reviewed agency in socioecological transformation and matched social innovation strategies with SES adaptive cycle phases, suggesting that innovation within a SES depends upon the ease with which organizations can promote joint action and the extent to which institutional structures foster the type of innovation required in that system phase.

Drawing on the literature covering the theory and application of AIS and SES frameworks in diverse contexts, Fig. 5 shows a conceptual diagram of how CARICOM policy institutions might better approach the problem of

low adaptive capacity in the domestic agriculture-food systems of SIDS. This diagram is based on a recognition that responding to environmental change and shocks (social, political, economic, and environmental) to domestic agriculture and food systems will need to build upon and expand existing social system agency in order to foster social transformation and innovation. According to Westley et al. (2013), this will involve questioning of arrangements, undermining of existing rules and authority, and the need for increased interaction to foster new collaboration toward common goals. In particular, fostering innovation in the region's smallholder farming systems will require more decentralized social systems where mutually supporting relationships among diverse social actors are mediated through connections with the natural environment (Anderies et al. 2004). In Fig. 5, social resilience is shown as the pivot of human–nature interactions in SIDS, cutting across the three intersecting policy domains of domestic smallholder farmers, global environmental change, and regional food and nutrition security, each of which suffers from low levels of innovation and adaptive capacity. This is because any efforts to build adaptive capacity, or lessen vulnerability, will be dependent on the capacity of new institutions and social actors to buffer against disturbance, self-organize, learn, and adapt across scales (Carpenter et al. 2001; Obrist et al. 2010; Tompkins and Adger 2004). The diagram also depicts the intersection of numerous complex and “wicked” policy challenges (Norton 2005) which support the need for more decentralized and system-based approaches.

Previous research by Butler et al. (2014) has combined AIS and SES resilience thinking to examine adaptation

Fig. 5 Framework depicts social resilience operating at the pivot of human–nature interactions in SIDS, cutting across the three intersecting policy domains of domestic smallholder farmers, global environmental change, and food security; intersection of socioecological systems resilience in the literature; questioning and undermining of institutions (formal and informal); and need for innovation requiring increased interaction in response to shocks and crises



pathways in Indonesian islands and provides some general guidance on how an integrated AIS and SES approach might be operationalized, including: multi-scale analysis of livelihoods within the SES; development of multi-stakeholder processes (e.g., innovation platforms); and emphasis on governance through adaptive co-management. Our review of the literature supports the potential utility of these steps in the context of the domestic agriculture and food systems operating in CARICOM's SIDS and points to the following opportunities to foster innovation: (1) facilitating institutional diversity that fosters local knowledge and governance; (2) creating conditions that support interaction for collaboration, co-learning, and adaptation at multiple scales; and (3) supporting agroecological approaches to local food production systems (Bahadur et al. 2013), each of which is further discussed below.

Facilitating institutional diversity that fosters local knowledge and governance

Institutional diversity can facilitate improved local knowledge from varied sources, enhance governance structures, and provide the basis for community-based development approaches (Bodin and Prell 2011; Pelling and High 2005; Tompkins and Adger 2004). The formal institutions operating in the agriculture and food systems of the CARICOM are generally characterized by a state-led focus on managing food exports with markets directing imports (Armstrong and Read 2002). In the context of British ex-colonies, Lange (2009) observed that rather than promoting broad-based development following independence, state institutions have remained relatively static, reinforcing previous colonial hierarchies and centralized power. A good example of this situation is the Windward Islands Banana Growers' Association, co-owned by the four Windward Islands (Dominica, Grenada, Saint Lucia, and Saint Vincent and the Grenadines), which when commercialized into the Windward Islands Banana Development and Exporting Company Limited in 1994 witnessed minimal institutional change. The importance of focussing on the issue of adaptive capacity in these relatively young institutions is supported by a recognition that promoting innovation through enhanced interactions, supportive rules, and two-way knowledge flows (Berkes and Folke 1998) will require more decentralized, adaptive, and heterogeneous institutional structures. These structures will be considerably different from the often authoritarian, top-down, technocratic, state-led agricultural production institutions enacted by parliament that dominate the Caribbean (Adger et al. 2005; Allison and Hobbs 2004; Folke 2006; Tompkins and Adger 2004), such as the Guyana Rice Development Board (3/1998) and the Coffee Industry Board of Jamaica (146/1999). Further studies into different

institutional forms and how they can influence social actors in Caribbean SIDS contexts are needed in order to provide a better understanding of how domestic agriculture and food system innovation might be enhanced in the region.

Studies by Osbahr et al. (2010), Aligica and Tarko (2014), and Ostrom (1999) have shown that more context-specific, multilayered, and polycentric institutional structures can foster more equitable governance arrangements and have the potential to counter historical social hierarchies, power differences, and class divisions. These structures have also been shown to be more suitable for enhancing the transfer of knowledge and interaction between diverse social actors (Bahadur et al. 2013; Kilelu et al. 2013). The development and maintenance of technocratic institutions in the agriculture and food systems of CARICOM have had the effect of stifling system innovation and creativity by sustaining hierarchical power differentials and limiting the evolution of more locally appropriate institutional designs (Lam 2011). This is supported by the FAO (2013) who identified the need for policy reform in the region to develop institutions better tailored to small-scale agriculture. Such reforms would benefit from clear institutional diagnoses (see Amankwah et al. 2012; Hounkonnou et al. 2012; Totin et al. 2012) to detect constraints, highlight openings for intervention, the key intermediaries functioning, and the development of multi-stakeholder groups (Struik et al. 2014b). While innovative multi-stakeholder governance pathways in AIS are conceptualized as iterative and adaptive, capable of fostering learning and conflict resolution (Amankwah et al. 2012), existing deficiencies in collaboration, and innovation systems may serve to limit institutional evolution and maintain the "status quo." In these situations, more flexible policy structures and facilitation mechanisms may help to enhance decision-making to better meet conflicting and multifaceted objectives (Kilelu et al. 2013; Klerkx et al. 2010; Swaans et al. 2013). In the context of Sub-Saharan Africa, innovation platforms, which comprised of multi-stakeholder support networks operating within a geographic area, have been shown to enhance agricultural innovation by bridging critical social, economic, technical, and institutional gaps (Kilelu et al. 2013; Klerkx et al. 2013). While innovation platforms identify problems, seek opportunities, and develop solutions (Adekunle and Fatunbi 2012), change agents or innovation entrepreneurs are also needed to galvanize change in complex systems (Klerkx et al. 2013; Westley et al. 2013) which can be derailed by power dynamics and limit effectiveness of participatory processes (Foran et al. 2014). The adaptive co-management model, which supports power and knowledge-sharing among stakeholders from multiple levels through reflective learning and innovation, is another approach that has already been applied in other natural

resource sectors in the region (notably in fisheries, coastal zone, and watershed management) (Tompkins and Adger 2004) and may offer valuable insights for domestic agriculture and food systems governance. According to Sandersen and Koester (2000), these may include how to get commitment to the devolution of state power, how to develop dynamic mechanisms to resolve conflicts, how to manage social diversity and power asymmetries, and how to enforce rules based on agreed-upon social norms.

Creating conditions that support interaction and adaptation at multiple scales

The absence of an enabling cultural environment needed to support innovation (Lederman et al. 2013) particularly within the region's historically two-tiered food production system hampers learning and knowledge exchange. More specifically, procedures are needed to govern behavior and facilitate collaboration, co-learning, and collective action for adaptation (see Dessie et al. 2013), while there is also a need to create environments that are conducive to realizing two-way communication flow (formal and informal), consensus, and change (Struik et al. 2014a; Struik et al. 2014b; Temby et al. 2015). These changes often require a systemic reassignment of the collective resources that created the division or what Hart in Guha-Khasnobis et al. (2007 p. 33) described as "a massive cultural effort" directed toward support for learning and adaptation at multiple scales.

Both SES and AIS approaches require a high degree of interaction between social actors and organizations in order to support institutional and cultural change and foster innovation in attitudes, values and norms from the farm to the community, private and public sectors, NGOs, and wider society (Hounkonnou et al. 2012; Olsson et al. 2014; Westley et al. 2013). One way that this can be accomplished is by mobilizing and building social capital in the form of trust, reciprocity, and social networks (Folke et al. 2005) across the domestic agriculture-food systems operating in CARICOM SIDS. Social capital comprises three dimensions: bonding (horizontal within group ties), bridging (horizontal ties bridging distinct groups), and linking social capital (vertical ties to power, finance through shared tasks toward the common good) (Grootaert et al. 2003; Sabatini 2009). Importantly, not all social capital is equal, with different dimensions playing different roles in the innovation process. While van Rijn et al. (2012) in their study on smallholder farming systems in seven Sub-Saharan African countries identified social capital and innovation as complementary, they suggested that while structural social capital (bridging) enhanced innovation adoption, cognitive social capital (bonding) among homogenous groups served to limit innovation by maintaining the status quo. Studies in the Caribbean have suggested that an

enhanced understanding of social capital dynamics within communities could improve policy and practice (Adger 2003; Pelling and High 2005), by encouraging social actors to co-learn and collaborate (Pretty and Ward 2001). Perhaps most importantly, the capacity of policy processes and institutions to build bridging and linking social capital across actors in the agriculture-food system will likely be directly related to their ability to overcome historical legacies of inequity and marginalization, which dominate the social memory. Social memory involves widely accepted practices based on experiences activated by a collective in response to various shocks (Folke et al. 2003). High levels of distrust among actors in the domestic agriculture-food systems of the CARICOM (Lowitt et al. 2015) are likely embedded in the social memory that has resulted from coercion and authoritarian exploitation and may foster bonding social capital between marginalized smallholder farmers and undermine efforts to develop bridging and linking social capital in support of innovation and collective action. Existing linking and bridging social capital between organized actors in the agriculture-food system, such as policymakers, international donors and scientists, may offer an important entry point for developing the smallholder agricultural innovation system (Fischer and Qaim 2014) through more participatory and decentralized processes of research, deliberation, and decision-making that can foster trust and the "cross-fertilization of ideas, methods, and expertise" (Brooks and Loevinsohn 2011 p. 195; Real and Hickey 2013).

Despite the recognized need for more flexible policy frameworks and decentralized innovation processes to support the development of social capital in the domestic agriculture-food systems of the CARICOM, a significant gap remains between potential and actual practices in most countries, with negative implications for smallholder farming systems. Informed by Rogers' (1983) diffusion theory, most agricultural extension practices in the CARICOM have followed a conventional linear approach to knowledge flow, where knowledge is developed by scientific researchers and delivered through government agricultural extension officers to individual farmers (Ganpat et al. 2009). According to Ganpat et al. (2009), the large gap between agricultural extension theory and practice in the region stems from: (1) weak linkages between agricultural research and education; (2) limited coordination of limited resources; and (3) inadequate adaptation of the institutional structures to meet existing needs and resource limitations. As the region confronts the challenges of developing resilient smallholder farming systems, dynamic and organic learning systems will be needed to allow farmers to critically assess and adopt new practices or technologies (Zilberman et al. 2012). Mobilizing disconnected policy actors (e.g., farmers, consumers, health practitioners, and importers), institutions, and sectors

operating within the CARICOM agriculture-food systems (for example through innovation platforms) can help support adaptive capacity by building trust, social capital, and widening knowledge networks, but will require redeployment of human, financial, and social capital (Lowitt et al. 2015). This task will also involve creating opportunities for diverse social actors to work together, develop joint visions, meet varied knowledge needs, and identify and respond to change (Klerkx et al. 2013); which may be supported by innovation platforms that seek to orchestrate change agents (Kilelu et al. 2013; Swaans et al. 2013) and connect them at different scales (Westley et al. 2013).

Supporting agroecological approaches to local food production

Despite institutional similarities, the high degree of diversity in both the population sizes (e.g., 2.7 million in Jamaica compared to 70,000 in Dominica (World Bank 2014)) and natural resource bases (e.g., Guyana has an area of 216,970 km² compared to Montserrat with 103 km²) of CARICOM nations results in varied opportunities for agricultural development (CARICOM 2011). As a result, complex system approaches are needed that can go beyond “overly simplified institutional prescriptions” or the “panacea problem” (Ostrom and Cox 2010) that often serve to limit the capacity of the domestic agriculture and food sectors to respond to change (Thompson and Scoones 2009). Agroecological approaches offer an alternative approach to research and policy that contrasts with the monoculture plantation approaches that have unsustainably used natural resources in the CARICOM region and left domestic food systems vulnerable to shocks (Simpson 2010). More specifically, intensive commodity-oriented production in the CARICOM has resulted in high levels of deforestation and loss of wildlife (Bramwell 2011; Crichtlow 2005; Watts 1990), spiraling soil erosion (Cox and Madramootoo 1998), coral reef destruction (Pandolfi and Jackson 2006), and subsequent economic vulnerability of food systems and national economies (Andreatta 1999; Deep Ford et al. 2007). Previous research has demonstrated that agroecological approaches have the potential to be successfully applied in the region (Brierley 1988); however, further research and supporting policies are needed to encourage more ecologically based agricultural production (Simpson 2010). For example, building upon proven low-input traditional agronomic practices would support livelihoods, especially pro-poor. Additionally, it would likely help support sustainability in these communities (Blay-Palmer 2010; Buttel 2006).

Key principles of taking an agroecological approach include: supporting diversity and redundancy, building

connectivity, managing slow variables and feedbacks, improving understanding of socioecological systems as complex adaptive systems, enhancing learning and experimentation, increasing participation, and encouraging polycentric governance systems (Biggs et al. 2012; Mercer et al. 2007; Tomich et al. 2011), all of which offer important insights for how institutions and actors might foster innovation in the domestic smallholder farming systems of the CARICOM. In the context of West Africa, Struik et al. (2014a) posed four questions that may also help guide CARICOM member states to better approach agroecological approaches to local food production: (1) How can context-driven change be sustained in dynamic agroecological settings? (2) How can practice build on best practice in institutional innovation to build resilient agroecosystems? (3) How can dual goals of sustainable intensification and improved pro-poor rural livelihoods be aligned?; and (4) How can policies be designed to protect smallholder farmers against global market shocks?

Science has an important role to play in this thinking by: (1) developing new tools that integrate mixed data sources to inform decision-making; (2) conducting assessments based on multiple criteria that can be used to prioritize, evaluate, and predict impacts and trade-offs at different scales; and (3) enhancing knowledge development on local species and traditional practice to assess their contribution to developing sustainable food systems (Caron et al. 2014). However, as noted by Tiftonell and Giller (2013), researchers and policy makers also need to be careful not to romanticize traditional practices which may limit smallholder farming systems in realizing their potential, resulting in “poverty traps” that can prevent the adoption of good agronomic practices and sustain low soil fertility.

Conclusion

Fifty years since their independence, CARICOM SIDS continue to grapple with their unique food and nutrition security challenges that have resulted from historical plantation legacies that support cyclic vulnerability within a two-tiered agriculture-food system. These challenges range from degrading natural resources, declining exports and rural livelihoods, high production costs, small populations and domestic market size, increasing food imports, growing rates of obesity and NCD, and disaster proneness with production difficulties arising from environmental change. Improving adaptive capacity in the domestic agriculture-food systems of CARICOM will require enhanced coordination, collaboration, and innovation. However, export policy “lock-in,” limited investment in agricultural development, structural openness with associated susceptibility to economic, environmental, and

political change, and inattention to the unique sociohistorical context of the region have limited attempts to revitalize national and regional policies and practices.

By combining AIS and SES frameworks in the context of CARICOM smallholder farming system innovation, this paper identifies social resilience as the pivot point for improving human–nature interactions and points to the following opportunities to foster innovation: (1) facilitating institutional diversity that fosters local knowledge and governance; (2) creating conditions that support collaboration, co-learning, and adaptation at multiple scales; and (3) supporting agroecological approaches to local food production systems (Bahadur et al. 2013). More specifically, we highlight how resilience and innovation in the smallholder farming systems of the CARICOM could be enhanced through greater interaction among social actors and institutions, allowing them to better navigate the ill-defined issues, power hierarchies, and limited collective learning processes that generally exist in the region. Research gaps are subsequently identified, including the need to better understand how social capital and cohesion can facilitate resilience in diverse smallholder farming contexts; how formal and informal institutions interact in domestic agriculture and food systems to constrain or provide opportunities for collaboration and collective action; how social actors might better perform bridging and linking roles (e.g., innovation champions, knowledge brokers) to support mutual learning, collaboration, and reciprocal knowledge flows; and the reasons for past innovation failures and successes in the region to facilitate organizational learning. Ultimately, there is a need to increase the interactions, knowledge flows, and interconnections between the formal and informal institutions and diverse social actors who drive domestic agriculture–food systems in the CARICOM.

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