

Local Innovation: what it is and why it matters for developing economies

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MIT D-Lab Local Innovation Group

D-Lab's Local Innovation Group conducts multi-disciplinary research on innovation processes and outcomes in communities facing development challenges around the world, particularly in the Global South. The group focuses on understanding innovation in under-studied contexts, including grassroots and community-based settings.

Through research and evidence synthesis, the group develops actionable knowledge on how innovation works in these contexts and how it can be effectively encouraged to promote sustainable local and regional development.

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Local Innovation: what it is and why it matters for developing economies

Working Paper 01

May 2018¹

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ABSTRACT:

There is a nascent but growing body of work on innovation in community-based settings, including what is termed grassroots innovation, jugaad innovation, user-driven innovation, and autonomous innovation. This paper examines a related concept, that of local innovation—the creation of new and improved ways of doing things compared to existing practice within a specific local context. Drawing on existing literature and three years of qualitative interviewing and case study research into local innovation processes in Africa, Southeast Asia, and Latin America, we find promising early evidence of the value of local innovation to developing economies, and particularly to the localities where this innovation is taking place. We find that the innovations emerging from these processes create meaningful livelihood impacts for their users and that, more significantly, the act of innovating contributes to building and strengthening a set of system capacities which are essential for local economic development.

1. Introduction: local innovation as an emerging topic of inquiry

For at least one hundred years, innovation has been acknowledged as a key force contributing to and sustaining processes of economic and societal development. “The basis for development is the ability of individuals, organizations, and societies to improve on what they are currently doing, i.e. to improve their individual and collective capabilities.” (Spielman, et. al. 2009, 72). Nevertheless, academic inquiry into innovation and its relationship with development is a young field of study, even by the standards of the social sciences. Several comprehensive surveys of the field of innovation studies showed that as of 2005, the majority of scholars working on innovation were based in American or European universities and focused on studying innovation in the context of industrialized economies, typically looking at innovation processes within firms, between firms with formal R&D activities and universities, or within regional or national “systems of innovation”

¹ An early version of this paper was presented to the Economics of Innovation Working Group at the YSI Plenary Conference in Budapest, Hungary, October 2016. The author thanks Lauren McKown for her comments and feedback on a previous draft.

(Fagerberg and Verspagen 2009; Fagerberg et. al. 2012; Lorentz 2013). A recent volume from Oxford University Press on Innovation Studies, which provided an overview of the state of the field as well as future directions for research, explicitly reflected this focus on innovation within formal sector organizations based in developed, Western contexts (Fagerberg, et. al. 2013).

However, over the past 15 years a growing body of work has started to examine innovation in a new set of under-studied contexts, some of which have particular relevance for developing economies. The first of these contexts is innovation which takes place within peer-to-peer networks of product users, and has been referred to in the literature as “open innovation,” (Chesbrough 2006) “horizontal innovation,” (von Hippel 2007) and innovation driven by “lead users,” or simply, “user innovation” (Franke and Shah 2003; von Hippel 2007; Mahr and Lievens 2012; Van der Boor, et. al. 2014). This type of innovation often transcends organizational and locational boundaries, relying instead on digital connectivity to link participants in the innovation process across disparate locales. The second body of work examines innovation in the context of resource-constrained communities in what is frequently referred to as “the Global South” (primarily sub-Saharan Africa, South America, the Indian sub-continent, and Southeast Asia).

In these contexts, innovation can and does occur outside of formal structures such as firms or research units, taking place frequently in community-based settings such as homes, villages, craft workshops and among informal and semi-formal networks of loosely-connected actors and stakeholders (Mhula Links, Hart, and Jacobs 2014). Innovation in these contexts has been referred to as “grassroots innovation,” (Gupta 2000; Gupta 2003; Smith, et. al. 2013), “informal innovation” (Mhula Links, Hart, and Jacobs 2014), “rural innovation,” “pro-poor innovation” (Berdegué 2005), “frugal” or *jugaad* innovation (Bound and Thornton 2012; Radjou et. al. 2012), “local innovation,” (Friis-Hansen and Egelyng 2007; Wettasinha et. al. 2008), and “endogenous innovation,” meaning that it is generated from within the local community, rather than from outside of it (Asseffa et. al 2009). A more recent framing of this phenomenon that incorporates features of several of these other concepts is that of “autonomous innovation,” which refers to “good-enough, unaided innovations developed by people in low-income communities, producing solutions that iteratively respond to the challenges or opportunities facing their local situations and their interests and values” (Bahadur and Doczi 2016).

Most works to date examining innovation in informal and grassroots settings are descriptive in nature, focused on identifying examples of this type of innovation, describing how they differ in process and outcomes from innovation in formal and industrialized settings, and exploring the relevance and usefulness of this type of innovation to addressing challenges facing those who have been largely left behind by existing market forces (see for example: Mhula Links, Hart, and Jacobs 2014; Sheikh 2014; Abrol and Gupta 2014 and Tello-Rozas 2015). These works have largely been aimed at demonstrating that these alternate forms of innovation exist, on making a case for researching them, and on developing methods for conducting this type of research, including how to identify this type of innovation in the field (Wettasinha, et. al. 2008). Some of these works have also sought to make a case for the value that these types of innovation contribute to resource-poor communities or to the innovators themselves, but much less has been documented regarding the specific ways in which these types of innovation contribute to local and/or regional development.

This paper contributes to this nascent field of inquiry by examining one of these concepts—that of local innovation—and sharing early findings from the Local Innovation research group at the MIT D-Lab, which has been investigating the relationship between local innovation and development in the Global South. We start by introducing the concept of local innovation, focusing both on what it is and why it is relevant as a topic of study. This and related concepts have been defined differently by different authors, so we present the definitions that we have developed as a starting point for our subsequent research on this topic. We then share findings from the research conducted during the first phase of our work, which took place between 2014-2017 through the International Development Innovation Network (IDIN), a multi-institutional initiative funded through a 5-year agreement with USAID's Global Development Lab. After presenting what we have learned to date about the value of local innovation to developing economies, we discuss the implications of these findings for future innovation research and for informing changes in economic development policy and practice.

1.1 Conceptual foundations: what is local innovation?

Local innovation must be clearly defined as a concept in order to be empirically studied, especially given the absence of a single, authoritative definition within the existing literature. In developing our working definition of local innovation, we started from a definition of innovation more broadly. Innovation is generally understood to refer to new or different ways of doing things, which offer an improvement over previous approaches, and which gain a certain degree of use and acceptance within a system, market, or society (Friis-Hansen and Egelyng 2007, Frankelius 2009, Assefa, et. al. 2009). “Innovation” as a term refers both to the process of creating and introducing this new approach, and the result of this process, whether that be a device, technology, technique, idea, platform, etc. (Gault 2010; Friis-Hansen and Egelyng 2007; Frankelius 2009). Innovation can involve creating from scratch, adapting or significantly modifying an existing creation, or introducing the new and improved approach, device, etc. into society (Mhula Links, Hart, and Jacobs 2014). It can involve a single, radical improvement or a series of smaller and more gradual improvements leading to a significantly improved approach over time (Assefa, et. al. 2009, p. 37), summarizing Hall (2006). Innovation differs from invention in that it refers not simply to the creation of the new approach or thing (in the case where something is developed from scratch) but also to its use; if no one besides the inventor is using it, it is not considered an innovation (Assefa, Waters-Bayer et. al. 2009, Spielman, Ekboir and Davis 2009).

Local innovation possesses the same characteristics of innovation as a starting point, but with several distinctions which make it more specific as a concept and phenomenon. First, local innovation refers to the creation of ways of doing things that are new and improved within the specific local context in which they have been developed, even though they may not be seen as innovative in other parts of the world. Second, most existing definitions of local innovation agree that this concept refers to innovation processes that take place in a specific location involving people and resources from that same location, working to address problems or take advantage of opportunities that are locally relevant (Abrol and Gupta 2014). Some authors and organizations working with local innovators emphasize that local innovation is created by people in a specific place, “using their own resources and on their own initiative” (PROLINNOVA 2009), a definition which contains elements of the concepts of endogenous innovation and autonomous innovation mentioned earlier.

Through reviewing the existing literature and researching how local innovation manifests in practice, we have developed a slightly broader definition of the concept. We define “local innovation” as the process and the product of developing and introducing into use new and improved ways of doing things compared to existing practice within a specific local context, which involve local people and resources in addressing challenges and opportunities present within that context. Local innovation can also be thought of as vernacular innovation, as it occurs in settings that are typical, everyday settings in the local context. In the case of resource-poor and underdeveloped communities, these are typically informal, community-based settings (e.g. homes, community workshops, gathering spaces, outdoor spaces, etc.). While “local innovation” can, and often does, involve some non-local inputs into the innovation process (such as knowledge, inspiration, materials, or capital from non-local sources), it refers to situations in which people from a specific place take initiative to develop creative and effective ways of responding to challenges and opportunities that they face in the environments they encounter in their daily life.

As such, local innovation processes are engaged in by individuals, groups, and community-based organizations in countless communities around the world and examples of local innovation are abundant on every continent where this phenomenon has been researched. The international multi-stakeholder platform PROLINNOVA (promoting local innovation in ecologically-oriented agriculture and natural resource management) consists of 21 country-level platforms (multi-stakeholder networks) in Africa, Asia and Latin America, each of which supports and documents activities at the local level to identify, build capacity for and promote local innovation (PROLINNOVA 2016). In India alone, the Honeybee Network—a network of affiliated organizations promoting and supporting local innovation—has documented thousands of local innovations in a public database which contains over 10,000 examples of both local innovation and traditional knowledge, also sometimes referred to as indigenous knowledge² (NIF 2016; Abrol and Gupta 2014).

Like PROLINNOVA and the Honeybee Network, most networks or groups working on issues related to local innovation do so primarily from a programmatic standpoint, seeking to support, connect, raise visibility for and advocate on behalf of local innovators. A review of the existing literature on local innovation conducted by the author in 2014 found that most works to date reflected this focus on implementation and advocacy, seeking to describe or assess the results of particular interventions or strategies aimed at supporting local innovation processes and to share lessons learned from these experiences with implications for a practitioner and policy audience (see Friis-Hansen and Egelyn. 2007; Wettasinha et. al. 2008; Find your Feet 2012; PROLINNOVA 2012). These works in general offer clear and useful details on specific local innovation processes, the innovations resulting from them, and insights into the effectiveness of various strategies designed to support or facilitate these processes. However, we found few examples of studies designed to generate evidence that can add to a body of scientific knowledge regarding this phenomenon and its significance from a development standpoint (Smith 2013).

² While Honeybee does not differentiate between grassroots innovation and indigenous knowledge, most authors make a distinction which we follow in this paper. Indigenous knowledge produces ways of doing things which are unique to a specific place; they may therefore be seen as innovative from the perspective of outsiders, but they are commonplace and traditional ways of doing things in that place. By contrast, local innovation refers to a way of doing things that is fundamentally new in a particular place, even if it is commonplace elsewhere in the world (and therefore not seen as innovative by outsiders).

In light of this gap, in 2014 the Local Innovation Group at MIT D-Lab established as its research agenda to undertake and to incentivize social science research into local innovation and the relationship between local innovation and development. The over-arching question driving our work has been: what is the value of local innovation from a development standpoint, and how (if at all) does fostering local innovation contribute to development, particularly in the Global South? We have pursued three main thematic areas, which have served to guide individual research studies and projects. These themes are: 1) understanding local innovation processes and ecosystems, which involves descriptive research into what these are and how they function); 2) assessing the development outcomes associated with local innovation; and 3) identifying effective methods of enabling local innovation processes, focused particularly on informing how global actors such as universities, donors, and international networks can engage most effectively with local innovation processes and ecosystems.

2. Data sources

This paper presents findings from several research studies and projects which took place between 2014-2017 during the IDIN program. The first of these projects consisted of a review of existing evidence and secondary literature related to the contribution of local innovation to local and regional development. This review identified existing case studies and articles which have documented specific outcomes of local innovation processes, and/or of the innovations produced by these processes. As noted previously, most literature on local innovation to date has been primarily descriptive in nature, so very few cases specifying development outcomes were found. Nevertheless, this literature review process resulted in the identification of four cases that have informed our analysis and findings below. These cases are in Sri Lanka, Zambia, Bangladesh and the Philippines and have been documented in Uphoff 2000, Douthwaite, et. al. 2015 and in Douthwaite and Hoffecker, 2017.

The second and third projects are both ongoing and involve collection and analysis of primary empirical data. One of these projects involves in-depth interviews with and observations of local innovators and their innovation processes. This study has been led by the author and has involved undergraduate and graduate student researchers in the data collection process. To date, over 60 in-depth, semi-structured interviews have been conducted with local innovators in Ghana, Tanzania, Colombia, and India and three students involved in this project have published theses on their findings from the sub-set of innovators they have each interviewed.³ In cases of local innovation that have proven particularly interesting, these field interviews have been supplemented with additional information gleaned from secondary sources such as local newspapers, videos, and documentation provided by local organizations that have worked with and/or supported the innovators.

The other study involves case study research into processes of local innovation which have produced initial evidence of results from a development standpoint, as documented by practitioners and other researchers. Our study has picked up where existing documentation has left off to conduct in-depth primary research on these cases, employing a mix of qualitative methods

³ The graduate student assisting this project published his Masters thesis on findings from interviews he conducted with local innovators in India (Guttikonda 2016) and two undergraduate research students published a joint thesis on their findings from interviews with innovators in Ghana (Connors and Press-Wiliams 2016).

including semi-structured interviews, structured interviews, focus groups, field visits and observation, and review of archival and secondary material collected during field visits. Four such case studies were conducted, one each in Vietnam, Sri Lanka, Tanzania, and Cameroon. While the data analysis phase of this study is still ongoing, case-specific analysis involving outcome clustering has been conducted for three out of the four cases, and this analysis has informed the findings presented in this paper.

The final source of data informing this paper is data on local innovators who received support from IDIN during the 5-year program. This data is both quantitative and qualitative in nature and is accessible through a database which D-Lab staff can access, since it is collected as part of routine monitoring, evaluation, and learning efforts. Some of the data was gathered directly by IDIN program staff as primary data (based on informal interviews and observations during field visits) and some data was supplied by innovators as self-reported data (such as ongoing project updates, final reports for innovation grants, etc.). Finally, some data was supplied by IDIN organizational partners who in many cases provided direct support (e.g. funding, mentoring, workshop space) to local innovators. This data set provides a rich and varied source of information on local innovations in a variety of stages of development and allows us to gain real-time insights into the evolution of innovation processes as well as their results over time. This paper draws from an analysis of a subset of the data in this database, specifically, data on 89 local innovations (out of a total set of 166) which progressed beyond the prototyping stage and were in the “piloting” or “adoption” stage as of October 2017, meaning that they were in use by some number of users.

3. Findings: how local innovation contributes to development

Our research finds two primary pathways through which local innovation is contributing to local development in the contexts in which we have studied it so far. The first pathway is through the use and adoption of the specific innovations that are created and through the economic, social, and environmental impacts that the adoption of these innovations creates within the contexts in which they are adopted. The second pathway is through the contribution of the innovation process to the development and strengthening of key components of a local ecosystem for innovation and entrepreneurship, what has been referred to in different bodies of literature as local innovation systems as well as entrepreneurial ecosystems⁴ and what we refer to in our research as local innovation ecosystems.⁵ Below, we describe our findings related to both pathways and propose, based on our evidence to date, that the latter of these is the more significant pathway from the perspective of local and regional economic development.

3.1 Adoption impacts of local innovation

Local innovations are typically born from necessity when a person or group encounters a need or an opportunity so compelling that they feel it is worthwhile to put aside their daily routine and focus on developing a solution. In interviews with local innovators exploring what prompted them to innovate, the most common source of motivation we heard echoes this one below, from a 55 year

⁴ While innovation systems and entrepreneurship ecosystems are distinct concepts, both refer to the key actors, relationships, and elements that comprise an enabling environment for innovation specifically and innovation-oriented entrepreneurship more broadly.

⁵ We define local innovation ecosystems as place-based communities of interacting actors engaged in producing innovation and supporting processes of innovation, along with the infrastructure and enabling environment which allows them to create, adopt, and spread solutions to local challenges.

old farmer in India with only eight years of formal schooling who has created a solar-powered cotton-picking device:

“While removing cotton, not picking it within 20 days results in cotton falling to the ground and getting spoilt. Or a cyclone comes along and wets the cotton. The labor cost in removing cotton from the plants is also high...for a selling price of Rs. 3400 - 3500, Rs. 1000 goes to labor costs. I thought to myself - why can’t we make a machine that helps reduce these labor costs? I have been working on this for the past six years.” – Satyanarayana 2015⁶

The realization that “there has got to be a better way” and a frustration with the status quo, particularly regarding tasks that form a significant part of local livelihoods and daily routines, was the most common motivation cited by innovators in our studies, when describing what prompted them to innovate (see Table 1 for examples of the types of improvements offered by local innovations).⁷

The innovations they have developed in response therefore share certain key characteristics which in turn have implications for their impact on end users. Like Satyanarayana’s cotton picking machine, local innovations we researched address a local need that is common in the local context and is not being met by other actors. Because the innovation is developed by someone with an intimate knowledge of the need, who often starts out developing a solution for himself/herself or family members and neighbors, the resulting innovations are “frugal,” in that they contain only the most essential features to perform the tasks at hand, without over-engineering, or “bells and whistles” which might increase marketing appeal, but also often increase costs. Another local innovator from India, Zubaida Bai, has designed a “clean birth kit” which for \$2 contains the six most basic elements recommended by the WHO for a hygienic home birth, based on her personal experience of contracting a severe infection following the birth of her first child. This simple but potentially life-saving innovation exemplifies another characteristic which is common to local innovations we researched: they are designed with an acute awareness of local purchasing power in mind and are often significantly cheaper (in terms of cost and/or time) than existing alternatives, particularly those designed by foreigners.

Table 1.

Innovation	Place	Task	Improvement achieved
Peanut sheller	Morogoro, Tanzania	Processing peanuts, a staple food and income source	Reduces time needed to shell a 50kg bag of peanuts from 3 days to 10 minutes (time savings)
Avocado oil press	Arusha, Tanzania	Extracts oil from avocados	Enables production of high value-add product from excess avocados which were previously wasted (income generation for farmers)

⁶ Interview with Mullapudi Satyanarayana, conducted by Asresh Guttikonda, IDIN Graduate Research Assistant.

⁷ This finding is consistent with the findings from Abrol and Gupta (2014) who document that among 188 local innovators supported by the National Innovation Foundation (NIF) in India during the years 2001, 2002, and 2005, the primary “trigger” prompting them to innovate were problems that either they or someone they knew were facing, followed by observing the presence of an opportunity or possibility that innovation could address.

Innovation	Place	Task	Improvement achieved
Multi-crop harvester	Dar es Salaam, Tanzania	Harvests common staple crops, e.g. maize	Farmers can use one machine instead of three (cost savings)
Underwater river turbine	Kafue, Zambia	Produces electricity for a fishing village with no other source of electricity	Refrigeration of fishermans' catch and cell-phone charging (increases price of catch, reduces food waste, enables communication)
Bicycle powered groundnut mill	Kafue, Zambia	Grinds and sifts shelled groundnuts, a necessary step in processing	Reduces time required for this task from 2 days (for 1 person grinding 50kg of groundnuts) to 3 hours
Multi-functional, tractor-mounted seed dispenser	Andhra Pradesh, India	Performs five labor-intensive functions (making furrows, dropping seeds, adding fertilizer and weedicide and closing furrows)	Reduces labor involved in key steps required for zero-tillage farming, which is better for soil health but very labor intensive, also reduces waste in seeds (increases farmers' disposable incomes)
Saathi pads	Ahmedabad, India	Makes available low-cost, biodegradable sanitary pads from banana tree fiber	Enables women and girls to remain active during their periods, reduces land fill waste
Multi-stage water filtration system	Valle del Cauca, Colombia	Purifies and treats contaminated spring water naturally	Provides a reliable source of clean drinking water to a hillside settlement (health improvement)
Vermiculture processing using local inputs	La Calera, Colombia	Creates humus (fertile soil)	Makes small-scale gardening possible in an otherwise barren area (increases food security for families)

Analyzing over 300 local innovations included in our research, we can classify local innovations into four broad categories, based on the type of livelihood impacts they produce for their users. The first type of innovations are those which reduce the amount of time, burden, and labor associated with performing common livelihood and household tasks. These innovations, such as agricultural processing technologies, enable work that is an essential part of people's lives to be done more efficiently and with less physical strain than before. Examples include pedal powered washing machines, wind-powered rice threshers, oil presses, and the solar powered cotton picker mentioned above. These innovations increase incomes for their users both by making livelihood activities more efficient and by freeing up time which can be used for other productive activities.

The second type of innovation involves the development of new income-generating activities which were previously not possible. These innovations typically involve new processes, methods, or approaches to creating value and examples include the development of a locally feasible method of processing avocado oil (in Arusha, Tanzania), the development of a local system for waste recycling and reuse (in Lagos, Nigeria), and the development of techniques for cultivating new types of higher-value agricultural crops (in Hoa Binh, Vietnam and System C, Sri Lanka). These innovations enable users to develop new, higher productivity incomes streams (to increase their incomes) and also to diversify their incomes and therefore reduce the risks of income shocks due to crop failures or market fluctuations.

The third type of innovation addresses unmet basic needs related to health, sanitation, and wellbeing, particularly for the more vulnerable segments of the local population. Examples of this type of innovation include a method of producing home insulation from recycled waste paper (in rural Pakistan), a method of producing locally-manufactured, biodegradable sanitary pads for women and girls with no other options for menstrual products (in – India and Zambia), a process for manufacturing 3-D printed, adjustable shoes for children and adults suffering from jiggers, a debilitating infection which causes deformation of the feet (in Nairobi, Kenya), and the clean birthing kit mentioned above. These innovations have impacts on users related to improved health and sanitation, comfort, the reduction of stigma for certain conditions, and overall physical and social wellbeing for users.

The fourth broad category includes innovations that provide an essential service which enables other forms of economic or household activity. This category includes innovations that provide off-grid sources of power, such as underwater and wind turbines for electricity generation, methods of providing cooling and refrigeration (such as the MittiCool clay refrigerator in India, which uses evaporative cooling and operates without electricity), methods of filtering and purifying stream water for household consumption without chemicals (developed in Valle del Cauca, Colombia), innovative approaches to waste management, recycling, and upcycling (Lagos, Nigeria and Nairobi, Kenya), mobile apps which enable activities such as savings and financial management (PoupaCerto in Brazil) and basic accounting services for street vendors, informal business owners, and small and medium enterprises (SMEs) in (such as Uhasibu in Nairobi, Kenya).

With a small number of exceptions, nearly all local innovations we have researched so far address one (or more) of the four broad categories mentioned above. In cases where these innovations have been adopted by end users, we therefore see (and in cases where data is unavailable, assume) wellbeing impacts that reflect the value proposition of the innovation. For example, users of innovations designed to reduce labor and time to perform essential farm tasks will, by definition, experience gains from labor-saving, including increased profits on crops, increased time that can be used for other tasks (in cases where they were previously providing the labor) and/or increased disposable incomes (in cases where they were hiring the labor). Likewise, innovations that make new income-generating options possible result in both increased incomes as well as diversified incomes which are less susceptible to external shocks. This in turn, offers numerous follow-on benefits with development implications, such as the ability to keep children in school (even when primary crops or sources of income experience shocks), increased mobility (as discretionary income is often invested into some form of transport, particularly motorbikes in the cases of Vietnam and Sri Lanka), and increased opportunities to participate in non-farm activities such as local civic life and decision-making (particularly for women in the case of Tanzania).

While we find that livelihood impacts are significant, and even transformative, for individuals and groups who experience them, we also find that these impacts remain fairly limited from a development standpoint, due to the relatively modest reach of the majority of the innovations we have studied so far. While there are certainly examples of local innovations which have been successfully commercialized and have attained regional and even nation-wide use (particularly in India, where the Honeybee Network focuses on this process), the innovations we have researched are typically designed to meet very specific needs at the village or local community level, and often

are not manufactured at a scale that could reach a significantly larger user base (though they certainly could be). We see this reflected in the 166 innovations we analyzed in IDIN's database. Of the 89 of these which were in piloting or adoption phases at the time of conducting our analysis, 87% were being used by 500 people or fewer. The median reach of these innovations was 50 users, which makes sense within a rural, village setting in which the innovation is targeted to a sub-set of the general population. At this scale of adoption, innovations often succeed in changing the practices of individuals and groups, but not in shifting the overall market dynamics, behaviors, or norms which constitute the development context for local communities.

Given the hyper-local nature of many local innovations and the limited scale of impacts obtained through adoption and use alone, beginning in 2016 we broadened our research to begin investigating what other impacts, if any, local innovation might be producing. In the following section, we present the findings which are emerging from this line of research. As is argued below, these findings open up new avenues of inquiry regarding the value of local innovation from a development perspective while offering both an empirical evidence base and alternative conceptual and theoretical frameworks from which to understand processes of local and regional economic development.

3.2 Process impacts of local innovation

Existing research on innovation systems, particularly in the context of agricultural innovation systems (AIS), has identified that these systems must contain certain structural and functional elements in order to be able to produce innovation as well as effectively absorb innovations developed elsewhere (Wieczorek and Hekker 2012; Houkonnou et. al 2012). When these elements are weak or missing, innovations—whether developed locally or abroad—encounter barriers to uptake and diffusion, which have been shown to explain low rates of adoption of innovations with proven benefits for end users, particularly in the context of agriculturally-oriented communities in Sub-Saharan Africa (Houkonnou et. al 2012; Sterk 2013). Our research into innovation processes in rural communities of Sub-Saharan Africa, Southeast Asia, and South America has identified a growing number of cases in which the local innovation process itself is contributing to the development of key components of the local innovation system, and particularly to elements which form part of the enabling environment for innovation as well as innovation-oriented entrepreneurship.

Local innovators, by definition, are attempting and doing things which have not been accomplished previously in their local settings. As a result, they often encounter system constraints and challenges which they must address to some degree in order to be able to proceed with their innovation processes. When they realize, for example, that local fabricators lack the skills to build the parts they envision, they may need to work with them to develop the necessary expertise, pushing these workers to develop techniques they have not previously used (we have seen this in cases in India and Colombia). When they find that their community lacks workshop space where they can work on their prototypes, in some cases they decide to build one—initially for their own use but, in all cases we have seen, soon after for the use of other makers and entrepreneurs in their community (we have seen this in Zambia, Tanzania, and Colombia). When they begin to realize that mindsets in their local communities need to change to become more open to new ways of doing things or new products, we see local innovators branching out into activities designed to educate potential

consumers, as well as the community's youth, regarding the value of creative problem-solving, innovation, and entrepreneurship (we find cases of this in Zambia, Tanzania, Uganda, Kenya, Brazil and Colombia).⁸

Looking across our existing cases and data, we have identified five domains in which local innovators (both as individuals and groups) are developing the components of a more robust innovation ecosystem around them. The five domains include: 1) physical infrastructure, such as shared spaces, tools and technologies; 2) human capital, including knowledge, skills, know-how and capabilities; 3) networks and linkages (what we call "relationship infrastructure"); 4) actors and stakeholders; and 5) institutional conditions, both formal and informal. These five domains echo the four key structural dimensions which Wieczorek and Hekkert have highlighted as being essential for functional technological innovations systems, namely: actors, institutions, interactions and infrastructure (2012, p. 77, 79), so we use these broader categories to organize the presentation of our findings, albeit in a slightly different sequence.

Wieczorek and Hekkert use the category "actors" to refer to the actors engaged within a particular innovation system. We find that local innovators have expanded the number and the type of actors engaged in their local innovation ecosystem, both by engaging actors who were present in the local economy but not participating in innovation activity before and by contributing to the creation of new types of actors at the local level. In the first category, we see local innovators enlisting individuals and organizations in their innovation process who were not previously engaged in innovation. For example, local innovators often need to work with craftspeople, machinists, builders, software developers, and others with specific technical skills in order to manifest their new ideas. Similarly, we see some local innovators engaging extension agents, community development officers and other front –line government workers in their innovation processes, often as sources of technical know-how, sometimes as sources of connections or linkages to research and technical assistance.

In addition to bringing existing actors into their innovation processes, some innovators create new actors within their ecosystems, such as new organizations, new networks, new businesses, or new informal community groups in response to challenges and needs that they face in their own innovation processes. In this category, we see new local organizations and groups (both formal and informal) which have been created by innovators and their allies to provide access to resources that are necessary in the innovation process, such as physical space, tools, and production equipment (offered through innovation centers, maker spaces, hacker spaces, and other community-based organizations), access to seed capital and grant funds for innovation development (in the form of local innovation support funds, micro-granting programs, community innovation funds, and informal, village-based savings and loan groups), and access to information about supply and demand conditions, which is often obtained by setting up information-sharing networks or platforms (group meetings, Whatsapp chat groups, list-serves, and personal networks). In each of these cases, these groups are created by innovators specifically to address needs they identify during

⁸ These findings are consistent with recent findings by H. Creech, et. al. (2014), who in a survey of over 1,300 small-scale socially and environmentally innovative enterprises in Latin America, Africa, and Asia found that these enterprises "demonstrated a significant investment" in addressing "deeper system problems" in their local environments, turning them by necessity into "specialists in local community management, networking, training, institution building, and policy influencing." (Creech, et. al. 2014, pp. 370-371; 374).

their innovation process, but once created, these new actors start to play a role in maintaining and strengthening the local innovation ecosystem.

Moving from actors in the innovation ecosystem to the relationships and interactions between actors, we find that local innovation processes contribute to both expanding and strengthening linkages, or what we call the “relationship infrastructure” of the system. There are two primary changes we can observe in this area, which can, and often do, take place in tandem, and which follow from the development of new actors participating in the local innovation system. On the one hand, from the perspective of a particular village or hyper-local innovation system, once an innovation process starts we see new linkages being formed, both to existing actors who were previously disconnected from the innovation process and to new actors who emerge as a byproduct of the process, as mentioned above. We also see the strengthening of existing linkages, which occurs as innovators engage more frequently and intensively with their existing contacts, for example with potential customers, with input suppliers, with extension agents, and others. In many cases, innovators already had linkages to these actors, but before they started their innovation process these linkages were weak and infrequent. Through the innovation process (which at the grassroots level often can take years and many iterations before a truly workable new solution is developed), we see the intensification of certain types of relationships, for example: between innovators and providers of support services for innovation, such as technical know-how, seed capital, and skilled or semi-skilled labor.

Viewed from the perspective of the literature on social capital, we see examples of innovation processes contributing to building both bonding capital (intra-group) and bridging capital (inter-group) within local communities. This is particularly prominent as a feature of innovation processes that have been led by groups of people (e.g. teams, farmers’ groups, savings’ groups) rather than by single individuals. In cases we have researched in Sri Lanka, Tanzania, and Zambia, we see that as a group of villagers begins to work together on an innovation process (whether technical or social in nature), social capital is strengthened within the group, particularly in terms of trust between members, the development of group norms, roles, and processes (referred to as “structural social capital” in Uphoff and Wijayaratna 2000), and the development of a sense of “can-do spirit” within the group which contributes to a growing sense of collective efficacy. We also see increases in bridging social capital as members of these groups interact with other local and regional actors, such as financial institutions, organizations supporting local innovation, political elites in the community, and technical experts (including researchers and extension staff) in order to advance their innovation processes.

In addition to creating and strengthening relationship infrastructure, we see local innovators contributing to creating types of infrastructure which are essential to local innovation systems, particularly physical infrastructure and what Wieczorek and Hekkert call “knowledge infrastructure,” which can be understood as a form of human capital. In the category of physical infrastructure, we find local innovators—and those who engage with them in supporting the local innovation process—contributing to creating and/or strengthening several types of physical infrastructure, depending on what is needed for the innovation process at hand. Often, one of the most basic needs of local innovators is workshop space; a physical place to experiment, prototype, and develop their innovations which is outside of their home and which offers access to the types of

tools, instruments, or services (such as machining, programming, or marketing) which they need in order to develop their innovation. In cases where this does not already exist, we see example of local innovators either traveling to other towns to seek out these spaces and services, or deciding to create these spaces themselves to enable their own innovation process and later that of others in their community (in cases from Zambia, Tanzania, Ghana and Colombia).

Within these spaces (which IDIN terms “innovation centers”), we see local innovators creating other components of physical infrastructure for innovation, such as specialized tools, machines, and workstations (for example, with the energy requirements and special design to support welding, or with internet to support research), which enable various types of related work to take place in close proximity. This physical infrastructure, combined with the relationship infrastructure mentioned above, contributes to the development of new types of expertise and know-how, as innovators exchange ideas and work alongside others, including skilled artisans, local entrepreneurs, and other inventors and makers who are drawn to these spaces. In the words of this local innovator from Zambia:

“It’s also important to be able to combine skill-sets: for example, I was a carpenter before, but now I’ve entered into making machinery. Now [in the focus group with other innovators] we are listening to each other and hearing about each other’s innovations, so maybe I get an idea to start something related to mushrooms [the innovation of another focus group participant]; we also pick ideas up from other people.”

However, innovation centers are not the only vehicle through which new knowledge infrastructure is build. Even in cases in which local innovators lack access to workshop space, we find these innovators engaging with artisans, builders, machinists, local entrepreneurs, and other actors as they seek to find the expertise they need to develop their innovations.

By nature of the fact that innovators are attempting to do something that has not yet been done in their local context, they must enlist these others to engage in leaps of technical imagination, pushing them to work in areas in which they have not worked before (e.g. with new materials, or new methods, or at a degree of technical complexity they are unfamiliar with). This contributes to a gradual process of human capital development, both for the innovator and for the various individuals that he or she is engaging in the process. This upskilling of members of the local labor force through the innovation process is one of the most consistent patterns we see across the cases we have researched, and one of the clearest ways in which the local innovation process contributes to strengthening the local context for innovation and entrepreneurship.

In addition to the development of new skills, knowledge, and capabilities at the level of individuals and groups, we find that some local innovation processes have been successful in starting to shift attitudes and mindsets related to innovation and entrepreneurship at several different levels within local communities. At the personal level, many innovators have told us that their own attitudes and mindsets have shifted as a result of innovating and that after their first innovation, they have become more confident in their ability to come up with solutions, even outside of domains in which they have worked before. They also report that the views of others in their community towards them, and towards innovating in general, has started to shift, from viewing innovators as

“oddballs” or iconoclasts to people who can develop creative solutions to many practical and pressing local problems. In the words of an innovator from a rural village in Zambia:

“Society also pushes us to innovate; once we have made the first innovation, people come to us to see if we can solve their challenges. If there is demand for something, even if you haven’t made it before, you don’t say “I don’t know how to make it...” You rack your brains to see how you can do it, for example, I started making charcoal cooking stoves, but then someone comes and says, “can you make this [other thing]?” So society drives us to make more innovations and continue innovating.”

What we see in this case and in others is that as some people start to innovate locally, others pay attention, and if the local innovation process gains momentum and results in useful local solutions, it begins to shift the attitudes of neighbors, local officials, and others towards innovation more generally.

We find this in particular in places in which local networks or organizations have invested in promoting local innovators by raising their profile in the local media (newspapers, radio), inviting them to regional trade fairs and expos, and/or connecting them with non-local sources of expertise (such as technical experts from larger cities, students from abroad, or others). This brings public attention to local innovators and casts local innovators in a positive light—as changemakers developing creative local solutions and setting a positive example for others facing similar constraints-- which is one of the objectives of initiatives such as the Honeybee Network, Prolinnova, and IDIN. Changing perceptions towards experimentation and innovation at the grassroots level, particularly within very traditional societies, is a first step towards changing broader institutional conditions, in the sense of official and unofficial rules, norms, incentives, and ultimately policies.

While these more entrenched institutional conditions can be quite difficult to change, we do see a few cases in which local innovation processes have, over time, contributed to changing particular dimensions of the institutional environment in ways that favor innovation and local entrepreneurship more broadly. In the Mahaweli System C in Sri Lanka, for example, we find that small groups of farmer-innovators with support from community organizers were able to change the lending practices of local financial institutions to extend credit to farmer groups (which they were not previously doing, as the risks were perceived as too high) and to reduce interest rates charged on loans. In the northern mountainous provinces of Vietnam, we see that successful joint innovation processes undertaken by farmers and local agricultural extension staff resulted in specific changes in both policies and practices of the extension system as well as the provincial Department of Agriculture, such as the allocation of department resources and budget towards more participatory methods of working with farmers and promoting farmer experimentation and innovation development, such as Farmer Field Schools (FFS) and Participatory Technology Development (PTD). In Tanzania, we see that international organizations supporting local innovation, such as Land o Lakes International Development and IDIN, have created new incentives and funding platforms for local innovators, such as regional innovation competitions (which award cash prizes to the most promising innovations) and community-based platforms to provide small seed grants for innovation development.

These elements—new institutional arrangements, new sources of funding, more receptive attitudes towards innovation, norms and values related to stepping outside of tradition—combine with the more tangible elements mentioned previously such as strengthened infrastructure and networks of relationships, to create a more robust and functional enabling environment for innovation and entrepreneurship. In other words, we see that the innovation process itself contributes to developing the local innovation ecosystem. In the cases we have researched, this has happened in an organic, bottom-up way, as innovators and those working with them have encountered particular system barriers at the local level and worked to address them for the benefit of advancing specific innovation processes and projects. However, when these system constraints are addressed for one project, it becomes easier to address them for others, so we see a process in which local innovators and their allies are leading the way in creating conditions in their communities that are more conducive for innovation and entrepreneurship generally. This type of process stands in contrast with the official innovation policies of regions or nations, which typically are implemented from the top down, focused on promoting specific sectors or export-oriented industry clusters, and which have largely ignored rural communities as a locus for innovation activity.

4. Conclusions and implications for economic development

Local innovation has been critiqued for generating solutions which are too specific in their scope and limited in their reach to make a dent in addressing the grand scale of the challenges associated with poverty. Early findings from our first three years of research into this topic indicate that this skepticism is partially warranted, but also based on an incomplete understanding of the ways in which local innovation contributes to economic development. What we have found to date is that while the innovations (technologies, solutions, ways of doing things) that are created are indeed fairly limited in the reach of their particular end-user impacts—particularly when spillover effects are ignored-- the innovation process itself can, and often does, produce local system impacts which are of much greater significance from a development perspective.

Specifically, we find examples of local innovation processes that have catalyzed the development and strengthening of key components of local innovation ecosystems, particularly in terms of structural components of these systems such as the number and type of actors in the system, the extent and quality of relationships and linkages between these actors, the knowledge infrastructure and physical infrastructure of the systems, the human and social capital in the system, and the institutional conditions necessary for the system to improve its functioning over time. These are all components of a local system which have been highlighted as being of fundamental importance to the ability of the system to both produce and to absorb innovation (Kebebe et. al. 2015; Schut et. al. 2016). They are also the components which have been highlighted through historical as well as empirical studies in economic development as being essential conditions for enhancing the productivity of a location and enabling productivity growth over time for the enterprises in that location, particularly in the face of intensified global competition (Jacobs 1985; Porter 2000).⁹ The significance of local innovation, therefore, lies not simply in the productivity gains, income gains, or wellbeing gains achieved through the use and diffusion of specific innovations in a community, but

⁹ See Michael Porter's seminal piece "Location, Competition, and Economic Development: Local Clusters in a Global Economy" (2000) for a summary of work on this topic as well as his framing of the enabling conditions needed for enhancing the productivity of clusters and sustaining processes of local economic development over time.

in the contribution of the innovation process to creating enabling system conditions that are necessary ingredients for economic development at the local level.

The importance of these enabling conditions is evident from an innovation systems (IS) perspective as well as a cluster analysis perspective, but is less visible from a conventional economic development perspective, which focuses on the productivity of individual firms or of specific types of commodities and their production, rather than on the productivity and functioning of the local economic system as a whole. Conventional policy prescriptions regarding economic development—particularly for underdeveloped nations but also for cities and regions in developed countries---have focused on targeting specific industries, sectors, and types of outputs (such as staple crops) for productivity improvements—usually through the introduction of specific technological packages, such as specialized machinery, high-yielding seeds, or information technology. Our analysis, along with other recent studies, suggests that this focus might be misguided in cases in which the target sector or economy has low existing capacity to absorb innovation and sustain innovation processes over time.

Furthermore, our findings related to the public goods created through the innovation process suggest that stimulating local innovation, even in sectors or domains that are of yet relatively unproductive and uncompetitive, can produce benefits from a local economic development perspective. This also stands in contrast with policy prescriptions grounded in conventional models of economic development, which since the time of the early classical economics (such as David Ricardo) have advised regions and countries to specialize their economies and focus on producing exports in areas where a comparative advantage exists, which can then be used to import the remaining goods that are needed, but which can be produced more efficiently elsewhere. This fundamental model of economic development through trade has driven the policies adopted by many developing countries, particularly those in Sub-Saharan Africa, many of which rely on a handful of major export commodities (such as maize, coffee, cocoa, copper) to drive their economies.

Work on local innovation offers a point of departure for developing evidence to support a different approach to economic development—one grounded in developing local capabilities to produce a diverse range of goods and services which meet local needs. Our early findings suggest that there are clear benefits to local economies of stimulating innovation activity even in product categories and sectors that are absolutely and comparatively less productive than their counterparts in other countries. It may be more efficient for a fish farmer in Zambia to import solar panels from China than to set about building an underwater turbine for electricity generation, but it is this latter activity which has prompted a series of other changes (e.g. creation of a community workshop and innovation center, trainings for young people in the innovation process, connections with a range of other local stakeholders who are supporting the turbine development, strengthening of the skills and networks of those involved in the project), which would not have reason to take place if he were not engaged in the act of innovating. At its core, innovation involves learning how to make things (and offer services) more effectively and more efficiently compared to the status quo. When local innovation processes involve multiple actors, these processes stimulate social learning, a process which is key to development and which cannot be readily purchased with foreign exchange.

While our findings reflect research on three continents and case studies of local innovation in a number of different local contexts, they are based on relatively short-term and exploratory research studies. In order to validate these findings with a higher degree of rigor, several areas of additional work are needed. First, it will be important to conduct case studies using the same methods we have used to date, but over a longer period of time and involving a wider range of stakeholders in the local context, to develop more robustness in the case study findings. In-depth case study research of innovation processes should be complemented with studies using other empirical methods such as social network mapping and quasi-experimental pre-post assessments of changes in the local enabling environment for innovation and entrepreneurship resulting from local innovation activity. Finally, more work is needed to develop methods of capturing the full range of livelihood impacts produced by using local innovations as well as being involved in their development. We see our initial work to date on this subject as hypothesis-forming research, which can indicate promising areas for subsequent hypothesis testing needed for the development of a robust evidence base in this emerging field of inquiry.

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