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PERSPECTIVES AND NOTES

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"Rambo root" to the rescue: How a simple, low-cost solution can lead to multiple sustainable development gains

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Abstract

Rugged and resilient, cassava is a bulky root crop that can thrive on poor soils. Cultivating it offers the potential to restore degraded land, which in turn may reduce hunger, generate livelihoods, fight climate change and even promote peace. As such, farming cassava offers a nature-based solution that can contribute to achieving numerous sustainable development targets. The authors acknowledge that scaling up production of any commodity may bring risks of deforestation and biodiversity loss through clearing forest areas. In the case of increasing cassava production, though, this may not be the case because cassava can be cultivated on land affected by degradation, and this resource is abundant; policies and initiatives exist to mitigate those risks; and the principal goal is to scale up a sustainable land use system.

Biofortied cassava chips. Photo by: Neil Palmer/CIAT

Cassava has earned the moniker "Rambo root" because it shares similar qualities with the eponymous movie character. It has a rugged appearance and embodies resilience. Evidence exists that the crop, otherwise known as yuca, mandioca or manioc, is one that can withstand and even thrive despite a temperature increase of up to 2°C in Africa by 2030 (Jarvis, Ramirez-Villegas, Herrera Campo, & Navarro-Racines, 2012). Thus, cultivating cassava could contribute to alleviating hunger, which constitutes the second Sustainable Development Goal. We elucidate below that this practice as a soil restoration tool may generate more sustainable development outcomes—a potential that warrants further examination—and that Colombia serves as a good testing ground for exploring the different possibilities that farming cassava could lead to which can form the basis for nature-based solutions that other countries with similar challenges may adopt (Barrena-González, Rodrigo-Comino, Gyasi-Agyei, Pulido Fernández, & Cerdà, 2020; Keesstra et al., 2018; Rodrigo-Comino, Keesstra, & Cerdà, 2018).

What makes cultivating cassava a noteworthy solution to addressing multiple sustainable development challenges is the ease of propagating it relative to other crops. Apart from carrying out weed control and fertilization, a farmer would only need to cut the stems from healthy cassava plants that have generated starchy roots and replant these stems in the soil. Unlike other crops, cassava can grow on poor soils (Food and Agriculture Organization, n.d.; Howeler et al., 2013; Jung, Cock, & Howeler, 1978; Kayombo & Lal, 1994; Maduakor, 1993) and, under ideal conditions, provide the highest amount of calories per hectare in most tropical countries (Fleuret & Fleuret, 1980). Poor soils characterize degraded land, such as areas deforested for agricultural and livestock use and later abandoned when productivity has declined considerably. Cassava therefore could make for an ideal crop to plant on these lands as a first step in making them productive again. Restoring degraded land, as some scholars note and we allude below, has relevance to not just SDG 15, on life on land, but also on SDGs 1, on no poverty; 2, on zero hunger; 8, on sustainable economic growth; 12, on responsible production and consumption; and 13, on climate action (Keesstra et al., 2016; Keesstra, Mol, et al., 2018; Visser, Maas, & Molenaar, 2019).

Specifically, cassava, being a bulky root crop, has the ability to break the soil, and thus prevent compaction and, by providing soil cover for nearly a year, erosion—threats that degraded land faces. This may eventually allow the land to be cultivated with other cash crops that cannot thrive under poor soil conditions, for instance, soybean and corn. Rotating or intercropping cassava with catch crops, including legumes that can fix nitrogen from the atmosphere, can further mitigate soil erosion (Cerdà, Rodrigo-Comino, Giménez-Morera, Novara, et al., 2018; Cerdà, Rodrigo-Comino, Novara, Brevik, et al., 2018; Cerdà, Rodrigo-Comino, Giménez-Morera, & Keesstra, 2018). These catch crops will produce biomass that turns into residues or mulch, which protects the soil from water erosion, helps sequester soil carbon and retain nutrients, promotes topsoil aggregation, enhances infiltration and restores soil health (Cerdà, Rodrigo-Comino, Giménez-Morera, Novara, et al., 2018; Guadie, Molla, Mekonnen, & Cerdà, 2020; Keesstra et al., 2018; Rodrigo-Comino et al., 2019). Over time, the land will become fertile and allow for planting trees, such as cacao. This creates an integrated sustainable farming system, which may even expand to include managed pasture for cattle grazing, that is, silvopasture, thus not only offering several potential sources of income for farmers but also promoting sustainability. Establishing the exact protocols and timeframes for this scenario will require research.

Given the above scenario, planting cassava makes a lot of sense for places with a significant expanse of degraded land and a high degree of biodiversity but at risk of further loss. Making abandoned areas that were earlier deforested for agricultural and livestock use productive anew may deter farmers from encroaching into nearby forest regions and consequently harming biodiversity. One country that fits the description is Colombia, which ranks second in the world after Brazil when it comes to the world's megadiverse countries.

The Colombian government estimates that roughly 40% of the national territory suffers some form of degradation (United Nations Convention to Combat Desertification, 2016). Much of the degraded land represents areas affected by conflict and where the government and its development partners are promoting cacao production as an alternative to illicit coca leaf farming and, in turn, as a vehicle for reducing deforestation and building peace (Castro-Nunez, Charry, Castro-Llanos, Sylvester, & Bax, 2020). Research indicates that there are links between coca leaf production, deforestation and the conflict in Colombia (Castro-Nunez, Mertz, Buritica, Sosa, & Lee, 2017). In this case, cultivating cassava as a way to prepare degraded land for the eventual propagation of cacao could also contribute to efforts in building peace, which is a core objective of SDG 16, on peace, justice and strong institutions.

From sowing, it takes three years before farmers can harvest cacao beans and generate income from planting cacao. In the interim, producers can rely on farming cassava, whose roots may be harvested as early as six months after planting (Howeler et al., 2013), prior to cultivating a portion of the degraded land with cacao, as well as on rotating cassava with other cash crops and on raising livestock while waiting for the cacao plant to grow, to not only to restore the health of the soil of degraded land and provide sustenance to their households but also earn from it. Globally, data suggest a continuously growing market for cassava starch: One estimate projects a growth rate of 3.2% from 2019 to 2024 (Market Research Future, 2020). In the case of Colombia, where cassava mainly ends up in the local market (Balcázar & Mansilla, 2004), a farmer would have received USD 272 for every ton sold in 2016 based on the latest FAOSTAT figure on the annual value of producer prices for the crop in the Latin American country. Table 1 presents the annual producer prices and production quantity of cassava in Colombia from 2001 and 2016. The strong local demand has prompted Colombia to import the commodity at times (5dias, 2016). Despite this high demand for starch, though, it is a concern whether or not cassava can compete with other starch sources, namely potato, maize and wheat, due to high labor costs in Colombia and the need to build starch extraction plants. Addressing such a concern necessitates evaluating the cost-effectiveness of these different sources of starch, taking into account their nutritional values, the values of the ecosystem services they provide and the costs to grow per hectare.

The potential of cassava to remediate soils that have high levels of heavy metal also merits additional research (Flores, Berbert, Victório, Direito, & Cardoso, 2019). One such heavy metal is cadmium. Cacao trees have a high

TABLE 1 Production and producer price of cassava in Colombia from 2001 to 2016

Year	Production, in million tons	Producer price, in USD/ion
2001	1.98	123.8
2002	1.65	90.7
2003	1.67	146.9
2004	1.66	119
2005	1.61	136.9
2006	1.70	179.9
2007	1.79	212.6
2008	1.80	205.9
2009	2.25	264.5
2010	2.08	241.3
2011	1.87	248.1
2012	2.22	351
2013	2.49	181
2014	2.19	272.2
2015	2.09	313.4
2016	2.11	272

Source: FAOSTAT.

capacity to take up cadmium from soils and accumulate this element in the cacao beans. Some cacao growing areas in Colombia, as in other parts of Latin America, are facing challenges exporting their cacao due to high cadmium levels (European Commission, 2014). Cassava appears to have the potential to absorb cadmium from the soil (Hilda et al., 2015; Magna, MacHado, Portella, & Carvalho, 2013). Additional research would validate this potential, and if it is indeed the case, cassava would help mitigate cadmium content in cacao and allow Colombian cocoa products to access foreign markets, such as the European Union. Starch from cassava that has taken up cadmium and other heavy metals (Ajiwe, Chukwujindu, & Chukwujindu, 2018; Harrison, Osu, & Ekanem, 2018) can be a source of dextrin, a type of adhesive used in manufacturing paper, textile, wallpaper paste, carton boxes and remoistening gum for stamps, among other industrial products (Grace, 1977).

Beyond its promise to recover degraded land, improve farmer incomes and contribute to peacebuilding, cultivating cassava can curb the dependency on some agricultural commodities linked to forest loss. Cassava starch may replace starch from crops like maize and soybeans (Atthasampunna, Somchai, Eur-aree, & Artjariyasripong, 1987; Food and Agriculture Organization, n.d.), two often-linked commodities that have caused deforestation in the Brazilian Amazon (Laurance, 2007; Trase, 2018). Scientists have attributed the fires that spread through the Amazon basin in 2019 on deforestation (Escobar, 2019), partly due to an increase in the demand from Chinese importers for South American soybean as a result of the Asian economy's trade war with the United States (Fuchs et al., 2019).

We recognize that scaling up production of cassava brings risks similar to those linked with other agricultural commodities, including exacerbating deforestation and biodiversity loss through clearing forest areas to accommodate the increased production. Farmers sometimes clear forests because they need more land for raising their crops. In this case, it is not necessary because cassava can be cultivated in land affected by degradation, and this resource is abundant. Although estimates vary as to the breadth of land degradation, it is clear that it is in the tens of millions of hectares in tropical countries alone (Gibbs & Salmon, 2015). Worldwide, land degradation "occurs over a quarter of the Earth's ice-free land area," according to the Intergovernmental Panel for Climate Change's special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems (IPCC, 2019). Policies and various initiatives also exist to mitigate those risks. More importantly, the goal is not about increasing cassava production but scaling up a land use system that allows for the achievement of multiple SDGs.

Degraded grazing land in Huila, Colombia. Photo by: Neil Palmer/CIAT

Realizing the potential of cassava as a key component of a soil restoration approach that delivers multiple sustainable outcomes will, as noted above, require more research. It will also need collaboration among and support from various sectors, including the government, academia, civil society, the private sector, and the conservation and international development communities. Through evidence-based, multidisciplinary and collaborative interventions, we could create more benefits for the local communities and beyond.

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CONFLICT OF INTEREST

The authors have no conflict of interest in publishing this paper.

AUTHOR CONTRIBUTIONS

Ma. Eliza J. Villarino: writing (original draft), review, editing, visualization (data presentation), planning and coordination. Mayesse Da Silva: conceptualization (land restoration), review. Luis Augusto Becerra Lopez-Lavalle: conceptualization (cassava), review. Augusto Castro-Nuñez: conceptualization (land systems and peacebuilding), funding acquisition, review, supervision.

DATA AVAILABILITY STATEMENT

The authors have no relevant data to share.

ETHICS STATEMENT

The authors have abided by the publishing ethics guidelines.

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