SDGs and Sweet Potato Cultivation

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The 2030 Agenda for Sustainable Development, including the 17 Sustainable Development Goals (SDGs), will shape national development plans up to 2030. SDGs 1 (No Poverty), 2 (Zero Hunger) and 7 (Affordable and Clean Energy) are crucial for the poor, given they target the basic human needs for development and fundamental human rights. Most poor and malnourished people in developing countries live in rural areas and engage in farming as a key part of their livelihoods, with food and agriculture at the heart of their development concerns. Crops that can provide both food and energy without detrimental impacts on soil or water resources can be particularly beneficial for local development and smallholder farmers. Sweet potato, in particular, is attracting growing attention from researchers and policymakers as it has the potential to address these global problems in a sustainable way.

Keywords: resilience ; agriculture ; biofuels ; bioethanol ; food security ; poverty ; energy ; nutrition ; livelihoods ; synergy ; trade-offs

1. Introduction

The majority of poor and malnourished people live in rural areas [1][2] and are dependent on smallholder agriculture [3]. It is well recognised that growth and development in the agriculture sector can play a critical role in reducing poverty and improving both food and energy security [4][5][6]. Smallholder farmers provide more than 80% of the food supply in Asia and Africa, where poverty and hunger are widespread [7]. Yet, the energy needs of smallholder farmers are often overlooked, with many dependent on woodfuel and/or charcoal. To improve the conditions and productivity of smallholder farms, and therefore raise the living standards of smallholder farmers, there is an urgent imperative to address the huge deficit in access to modern energy services they currently face. One intervention for doing so involves incentivising smallholder farmers to produce bioenergy crops from their land in a sustainable way, which they can then sell or use themselves. The recent expansion in liquid biofuel production using crops as feedstock in both developed and developing countries has opened new roles for agriculture in the energy sector [8], particularly in the context of climate change concerns. Using crops for energy rather than food, however, is a contentious proposition, with recognition of the need to assess the trade-offs (see e.g., [9]). Paying closer attention to smallholder farmers' livelihoods and development prospects, as well as assessing the trade-offs and opportunities offered by energy crops, could provide important insights to advance progress towards the SDGs [10].

Improving food and energy security, as well as reducing undernutrition, necessitates investment in higher on-farm crop diversity, alongside improvement of smallholder farmers' access to markets [3]. Further benefits for local development and smallholder farmers that could materialise from crops that can provide both food and energy include increased agrobiodiversity, diversification of farmers' income streams, as well as improved energy security [11]. Yet, constraints of climate change, land scarcity, rising global population, food and energy demand, and environmental degradation mean that there is a need for crops that are not land- and water-intensive, are resilient and can produce high yields of food and fuel. Most of the major crops used for both food and fuel do not address these needs. For example, sugarcane and maize are land- and water-intensive and are horizontally expanding over new lands [8][12]. Their large-scale monoculture production has not only reduced the resilience of the food system by promoting cultivation of only a few varieties, but is also working against the idea of inclusive growth by failing to provide better livelihoods, affordable food and access to clean sources of energy for the rural poor [13]. At worst, large-scale monoculture production has displaced local communities and their traditional livelihoods [14].

Alternative crops to sugarcane and maize have been put forward as an underexplored option with considerable untapped potential to support rural development [15]. Studies have looked at the potential of e.g., sweet potato, cassava, soybean, cowpea and pigeonpea, to diversify diets, support food security and provide beneficial ecosystem services [16][17], as well as enhance energy security [18]. Sweet potato, in particular, is starting to attract growing attention from researchers and policymakers, as it presents a number of potential opportunities for smallholder farmers in terms of improving agricultural productivity [15]. Sweet potato is among the most important food crops in the world for human consumption. It is mainly

produced in developing countries with low per capita incomes, which is why increasing production of sweet potato is considered as a means to improve food security and reduce poverty among the poorer segments of rural and urban populations [19].

Sweet potato is also one of the most underexplored food crops in the world [20]. Most research on sweet potato has been conducted from a biotechnological and agronomic point of view, to improve its quality and characteristics, such as colour, nutritional composition, yield and resistance to various diseases [21][22][23]. There is nevertheless a small but expanding body of work that looks at it from a development perspective, providing evidence as to how sweet potato can support smallholder farmers to make progress towards the SDGs.

2. Discussion

The SDGs have the potential to completely transform development by shifting the focus towards human development and ensuring basic needs are met [24]. The majority of the world's food is produced on small farms, which currently make up 90% of the total 570 million farms in the world [10]. Smallholder farming, given its multi-dimensional nature, can strongly contribute to the social, environmental and economic dimensions of the SDGs [25].

The rise in food demand due to population growth, increased income per capita, biofuel production and low food prices cannot be met by many of the major crops [26][27][28]. Other crops face difficulties due to productivity losses. Climate change is projected to reduce wheat yield by up to 72% and maize, rice and soybean yield by up to 45%, in regions such as sub-Saharan Africa [29]. Such challenges create opportunities for alternative crops, like sweet potato, to diversify economic activities and improve the development situation of smallholder farmers. Improving sweet potato production and competitiveness in developing countries could offer a possible pathway to alleviate poverty, improve food security, reduce malnutrition and provide access to modern energy sources, through inclusive growth (see Table 1) . Recent data reveal that sweet potato production has increased by more than 150% from 1994–2011 in sub-Saharan Africa and has experienced growth in China, with both regions producing about 87% of the total sweet potato production in developing countries [23][30][31]. Varieties, such as orange fleshed sweet potato (OFSP), are well accepted by both producers and consumers due to attributes such as its dry matter content [32][33][34]. Increased sweet potato production would be most effective in reducing poverty in developing regions due to high growth-poverty elasticities [35].

Table 1. Links between specific features of sweet potato and SDG targets linked to goals 1, 2 and 7.

Sweet Potato Characteristics	Contribution to SDG Targets
Sweet potato can create sustainable income generation opportunities due to its low-input requirements, high multiplication rate, high consumer acceptability and its potential for diversification into different uses.	**1.1, 1.2, 1.5, 2.1 and 2.3**
Sweet potato can enhance food security by addressing hunger, malnutrition and micronutrient deficiency due to its high nutritional content.	**1.1, 1.2, 2.1 and 2.2**
Sweet potato increased resilience during food shortages and mitigated the adverse impacts of disasters and famine.	**1.1, 1.2, 1.5, 2.1 and 2.2**
Sweet potato can reduce risks and promote sustainable agricultural production.	**1.5 and 2.4**
Sweet potato can empower women and girls and promote gender equality.	**1.4 and 2.3**
Sweet potato can safeguard biodiversity as it can encourage sharing of benefits among the farmers from the utilisation of sweet potato genetic diversity.	**2.5**
Sweet potato has important potential for biofuel production due to its high starch content and high bioethanol yield.	**7.1, 7.2, 7.3, 1.2 and 1.4**

Sweet potato, however, is under-researched relative to its contribution to healthy human nutrition. Consequently, the authors of [20] posit that sweet potato should become a high priority for future investigation, as well as receive additional investment, given its adaptation potential to climate change and its importance for food and nutrition security. Nevertheless, there is a variety of trade-offs stemming from use of sweet potato for food, related to access to energy and various social and environmental impacts. Similarly, fuel production from sweet potato can compete with food and feed production. However, many of these trade-offs remain unexplored. A recent study by [15] concluded that not much is known about the potential and sustainability implications of sweet potato's by-products or waste streams. Moreover, they note that there are several varieties of sweet potato, each with different characteristics, suited to the delivery of certain outputs (and related by-products), thus offering various market opportunities for smallholder farmers. Each of these varieties, however, will have its own particular set of trade-offs that require full exploration to ensure that smallholders are

not negatively impacted. A study by [36] (p. 48) has also highlighted the need for further multidisciplinary, integrated research and development activities aimed, among others, “at improving production, storage, postharvest and processing technologies, and quality of the sweet potato and its potential value-added products”.

Potential benefits and trade-offs can occur across the entire lifecycle of the crop, and this requires further scientific research. A key challenge is to bridge the huge gap between the actual and the potential yield of sweet potato. This goes some way toward explaining why, despite all the benefits it offers, sweet potato has not yet delivered a more substantial development contribution. Average yield in Africa is 5 t/ha, which is the lowest of all developing country regions and three times lower than the average yield for developing countries as a whole (15 t/ha). This, in turn, is well below the potential yield of above 35 t/ha, as recorded, for example, in Nigeria and Ethiopia using improved varieties [19][37][30][38]. Hence, increasing productivity offers a significant opportunity to tackle a number of major development challenges, like poverty, hunger, malnutrition and energy poverty through increased income, food availability and energy supply, and reduced food prices [39][40]. However, before productivity increases can occur, a number of factors limiting the profitability and efficiency of sweet potato production must be addressed. Among the most prominent are “poor storage methods, lack of processed products, transportation problems, unstable prices, and lack of improved cultivars and planting materials” [41] (p. 314).

Bioenergy production from sweet potato has the potential to be advantageous from a socio-economic perspective [15]. However, there can be disincentives for incorporating smallholders in value chains, due to greater cost and complexity. Limited capital and resources, technology and information, as well as high transaction costs, are some of the hurdles that make biofuel production for smallholder farmers a challenging proposition. As the authors of [42] note, infrastructural support (e.g., access to water, extension services, adequate storage technology, etc.) is also key if smallholders are to be convinced of the benefits of converting sweet potato into bioethanol. Enabling institutional environments are also paramount. Such an enabling environment should provide smallholders with a safe space for experimentation and innovation, as well as institutional support in terms of capacity building, sharing knowledge and experiences, and market development. It should also shield smallholders, to the extent possible, “from the changing context in which biofuel developments take place, preventing biofuels from becoming a threat rather than an opportunity for smallholders” [43] (p. 5127). A pertinent example here would be the Brazilian Social Fuel Seal [15].

A further challenge to harnessing benefits from sweet potato is presented by the COVID-19 pandemic. Hunger and malnutrition are expected to increase, with the poor and vulnerable most at risk [44]. The pandemic has affected market access for smallholder farmers, as well as disrupting food chains, causing increasing food loss and falling prices, as well as weakening their purchasing power. Several actors, such as the International Potato Center (CIP), have begun assessing the potential of sweet potato to strengthen food systems in developing countries during the COVID-19 crisis. One of the main advantages of sweet potato is that it is vegetatively propagated, with the seed system being characterised by a high degree of informality, with little to almost no existing private sector engagement. This informality allows sweet potato planting material to be produced and shared within village communities, an advantage major cereal crops with a high degree of formality lack [45].

3. Conclusions

Many of the major crops cannot meet the rise in food demand due to trends in population growth, increased income per capita, biofuel production and low food prices. Crops that can provide food and energy without detrimental impacts on soil or water resources, as well as provide local development benefits to smallholder farmers therefore offer important opportunities. Sweet potato-has the potential to address these global problems.

Advance progress towards the SDGs by offering multiple benefits: alleviating poverty, reducing hunger and malnutrition, enhancing resilience and reducing vulnerability, promoting gender equality, achieving more inclusive growth and improving energy security. At the same time, while sweet potato can generate development opportunities for smallholders, investments and institutional support are required to drive the situation forward and harness this potential. Further, sweet potato can be used for both food and fuel, presenting risks from numerous trade-offs at local to global levels. Lack of information and knowledge means the intricacies of the trade-offs remain unexplored and are an important area for further research.

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