Climate-Smart Agriculture as an Innovative Socioeconomic Sector for the National Economy

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Introduction

The Republic of Mauritius, as a Small Island Developing State (SIDS), is highly vulnerable to the impacts of climate change. Climate change is impacting all sectors of the economy in one way or another through increasing temperatures, erratic rainfall, increasing intensity and frequency of cyclones, sea level rise, increasing pests and diseases of humans, crops and livestock, declining soil fertility, changes in phenology of vegetable and fruit crops, etc. This is impacting national food and nutrition security, people's livelihoods, health and productivity, and also key economic sectors such as tourism, agriculture, and manufacturing. While adaptation in all the impacted sectors remains the main priority of the Government and the citizens, mitigation has not been neglected. The Government has pledged to reduce its greenhouse gas emissions by 30% by 2030. Agriculture being one of the largest emitter (17%) of GHG emissions (FAO, 2011), considerable efforts are being deployed to reduce emissions from agricultural soil and from various agronomic practices. Mauritian agriculture is highly dependent on synthetic chemical fertilizers, mostly nitrogen based (ammonium sulphate, urea), for maintaining soil productivity. Farmers use large amounts annually, and its usage is advocated by the Extension Services. According to the latest statistics, fertilizer consumption has increased from 33.1 tons in 2013 to 35.2 tons in 2017 (Statistics Mauritius, 2018).

Farmers try to adapt to the changing climate to the best of their ability through adjusting sowing dates, using new hybrids and higher yielding crop varieties wherever available, increasing dosages and frequency of pesticide and fertiliser applications, however their adaptation strategies are effective only over the short-term. Farmers therefore cannot rely on their conventional agricultural practices, and have to innovate if they wish to continue to sustain their farm productivity. The situation is ripe for sensitising and converting even the most die-hard and resistant farmer to a new approach to farming, namely Climate Smart Agriculture (CSA).

The CSA approach, proposed by FAO in 2010, is a solution to transform and/or reorient agricultural systems to support food security in the face of a changing climate. It aims to co-achieve three pillars: sustainably increasing agricultural productivity for national food security and development goals, enhancing resilience (adaptation), and reducing greenhouse gas emissions. Ideally CSA aims to attain 'triple win' outcomes from the local to the global scales and over short and long time frameworks, but trade-offs must often be made in agricultural development. Identifying synergies and weighing costs and benefits of different options based on stakeholder objectives is needed to derive locally acceptable and feasible solutions. The fact that CSA strives to reach multiple objectives at the system level makes it particularly difficult to transfer experiences from one context to another. Identifying context specific and

socially acceptable, relevant and viable options is essential, and must be undertaken using farmer and stakeholder-participatory processes, in order to ensure a sense of ownership and thereby buy-in.

Given the seriousness of the impacts of climate change on agriculture and rural communities, finding innovating pathways has become inevitable for these communities to adapt. Innovation has a pivotal role to play in promoting a resource-efficient, greener, and more competitive economy. Agricultural innovation can be classified in several ways: (1) responsible innovation, (2) technological innovation, (3) social innovation, (4) organizational innovation, (5) green innovation, (6) management innovation. Innovation can be brought about by all levels of stakeholders, including the business community, the public sector, civil society, and the communities. The general public too can make an important contribution.

Agriculture has been the bedrock of the Mauritius economy for decades. The sector has been servicing the needs of the population for years but food self-sufficiency today stands at only 23%. Presently, the sector represents 3.3% of the national economy, with sugar cane cultivation and sugar production as prime activities and employs around 40,300 people in the sector.

On the other hand, tourism is a key economic sector for the Republic in current times. A record number of tourists, almost 1.4 million, visited Mauritius in 2018 (up 4.3% from 2017). Mauritius continued to attract most of its tourists from Europe, which accounted for 59% of total arrivals in 2018. France alone accounted for 20% of all tourist arrivals. Helped by additional flight capacity, the Czech Republic and the Netherlands posted increases of 35.8% and 23.7%, respectively in 2018, followed by Germany at 11.7%. Africa accounted for 22.3% of tourist arrivals in 2018, 85% of which came from Réunion and South Africa (Statistics Mauritius, 2019). These figures represent an important potential that can be harnessed.

This growing tourism industry, coupled with the growing demand among locals for variety in diets, nutritious food out of health concerns, innovative and convenience products to match modern lifestyles, has set the stage for merging the agricultural and the tourism sectors, for a win-win situation.

Among the limited alternatives available for the rural agricultural communities, agritourism can be considered as a viable option both to minimize impacts of climate change as well as to exploit the opportunities associated with climate change (Mahaliyanaarachchi 2015). Valdivia et al. (2014) have also quoted agritourism as an adaptation strategy for climate change which would generate agricultural incomes while sustaining rural livelihoods. Agritourism is also promoted as an entrepreneurial economic diversification strategy in many parts of the world (Nickerson et al. 2001; Ollenburg et al. 2007; Valdivia et al. 2014). With the development of agritourism, the traditional livelihoods of farmers can be significantly enhanced (Mbaiwa, 2011). The farmers can turn their way of earning a livelihood from the traditional way to a more diversified approach incorporating tourism. The development of ecotourism has the potential to improve the ability of farmers to cope with the fragile natural economic environment, but also to play a positive role in alleviating the contradiction between traditional livelihood and ecological protection by farmers (Bi *et al.*, 2020). Agritourism is a specific form of tourism with a strong environmental component (Leco et al. 2012), and is usually defined as visiting a working agricultural setting (such as a farm, ranch) for leisure, recreation, or education purposes (Gil Arroyo et al. 2013; Mahaliyanaarachchi, 2015). However, even this form of agritourism needs to be changed into something more innovative and attractive to tourists, who are always in search of something new and something different for each vacation.

Our team, composed of University academics and a farmer association, have decided to introduce CSA to tourists as an innovative agritourism activity, with special health benefits of eating healthy food while also contributing their little bit to combating global and national environmental issues, such as climate

change. It gives the tourists a satisfying feeling of doing their little bit to fight climate change, protect the environment and also help the local farming communities by teaming up in the latter's efforts towards earning a sustainable livelihood. In this business model, CSA also provides an innovative marketing and branding tool for the high-end hotels the tourists stay in.

Undertaken with funding from the European Union and the Australian Government, the project, entitled "Transformation of Belle Mare village into a Climate-Smart Agriculture village for climate resilience, food security, and poverty alleviation of its farmers", seeks to develop and disseminate site-specific CSA technologies to farmers, to explore barriers and bottlenecks to CSA technological innovation adoption and diffusion, and to identify services which could enhance and secure the adoption of CSA technologies in the Mauritian agricultural sector. The project is currently being implemented in the coastal region of Belle-Mare, known for its scenic beauty and the chain of high-end hotels lining the beaches. The economic and environmental drawbacks of growing vegetables directly in sand make it imperative to provide the Belle Mare farmers with an alternative way of practicing agriculture. Climate Smart Agriculture is an excellent alternative for such farmers. Furthermore, the project is a pioneer in creating, for the first time, a platform where small scale farmers and the hotel industry can collaborate directly with each other to create agritourism opportunities that would benefit the farming community, the hotels as well as the tourists, while also helping to protect the environment, and to contribute to Government's efforts to reduce national emissions and meet its international obligations.

Status quo of Mauritian agriculture

Agriculture has been the bedrock of the Mauritius economy for decades. Starting from a monocrop sector, it is now fully diversified with over 711 tariff lines being produced locally and exported. While the industrial base of Mauritius has been considerably widened, the agricultural and agro-processing sector remains a vital pillar of the economy as sugar cane fields continue to dominate the landscape of the island. The sector has been servicing the needs of the population for years but self-sufficiency nowadays stands at 23%. Today, the sector represents 3.3% of the national economy, with sugar cane cultivation and sugar production as prime activities and employs around 40,300 people in the sector.

In its endeavour to reduce dependency on food imports, increase revenues and export earnings, government is actively encouraging agricultural and agro-industrial development with the introduction of budgetary measures which encourage import substitution, food processing, shelter farming, as well as production of higher end products such as nutraceuticals. In order to promote exports of agricultural products grown in Mauritius, Government has extended the Trade Promotion and Marketing Scheme which offers a 40% rebate on air freight cost for exports of agro & agri products to Europe, Japan, Australia, Canada and Middle East (EDB, 2022). There is an emergence of investors in the agro-industrial sector; and agri-business opportunities developing out of economic integration and free trade areas in the region e.g. SADC, IOC, AU and COMESA. All economic actors seek innovative products and services for developing new markets and catering for emerging trends.

There are about 12,000 small farmers registered in Mauritius. The Small Famers Welfare Fund (SFWF) operating under the ageist of the Ministry of Agriculture provides 60% subsidy on the purchase of organic inputs (fertilizers and pesticide) for three planting cycles (maximum five acres), discount on road tax on field vehicles, exemption from customs tariffs on commercial vehicles, reimbursement of VAT on the purchase of field equipment, rental of agricultural land and mechanization services, an allowance of up to Rs 10,000 for the acquisition of bar codes for processed agroproducts, and access to soft bank loans for the purchase of seeds.

Innovation brought by the project

The region of Belle-Mare is very distinctive in Mauritius for the number of 5 star hotels and the fact that agriculture is practiced on sandy soil which is very uncommon elsewhere.

The daunting challenge was how to transform local farmers who have been functioning traditionally for decades and to get them to shift and adapt to a new form agriculture based on an agritourism model. The method chosen was an inclusive, participatory one, where 15 planters were chosen as role models and demonstrators to implement CSA practices such as mulching, growing of melliferous plants, multi-cropping, addition of organic fertilizer in the form of manure, and reduction of chemical pesticides and fertilizers. These practices are foremost an eco-friendly and cost effective alternative to their conventional way of farming which mainly consisted of leaving the soil bare, regular tillage and massive reliance on chemical fertilizers and pesticides.

Participating farmers were given several incentives such as a tiller for mixing crop residues, a 9000L water tank and drip irrigation system, bio-pesticides and bio-fertilizer, seeds of melliferous plants, knapsack sprayers, and transport facilities. In addition to this, several training sessions on CSA technologies were held at regular intervals for the participating farmers, by a team of academic experts in the field. The project further offered regular monitoring and assessment of the farmers' plot, with various encouraging activities and schemes in order to keep them motivated and engaged in CSA. Previous local studies carried out had showed how resistant farmers were to change, and therefore it was imperative for the academic experts and the other project team members to be at the disposal of the farmers during the implementation phase for guidance, encouragement and continued engagement.

With the help of the participating farmers, a costing was made to demonstrate to other planters the cost benefits of transitioning from their conventional way of farming to the CSA approach.

Results and Discussion

As was empirically demonstrated to the farmers, transition from conventional agriculture to CSA reduced the cost of production by 57% for an average cropping cycle (Table 1). Cost of production was reduced by 66.8% when conventional synthetic fertilizers and pesticides were replaced by more sustainable practices such as addition of organic manure which are rich in nitrogen and phosphorous. Addition of mulch, not only helps to conserve moisture but in addition controls weed emergence. Planters usually employ a minimum of 3 labourers on weekly wages that correspond to around $13 per person to undertake manual weeding and/or spraying herbicides; this cost was reduced by 50% by applying full coverage mulching. Transition from conventional tillage to reduced tillage enabled farmers to reduce their cost of production for this farm operation by at least 50%. Addition of organic matter in the form of manure, crop residues and mulch decreases the intra-adhesion and cohesion between soil particles which helps to keep the bulk density of the soil relative low, hence providing an adequate soil tilth for crop production. This in turn reduces the need to practice tillage to break down clumped soil.

Table 1: Production costs for small scale planters under different agricultural approaches

Conventional Practices	**Cost per cropping cycle (USD)**	**CSA Practices**	**Cost per cropping cycle (USD)**
Fertilizer and pesticide	395	Organic fertiliser (compost, manure, scum)	131
Labour for weeding, sowing and harvesting	474	Labour for sowing and harvesting	237
Tillage	66	Reduced tillage	33
Total	**935**		**401**

Based on the above figures and the *de visu* benefits of CSA, majority of the participating planters adopted the CSA approach fully. Furthermore, other planters in the region, having observed the success of the participating planters, started emulating the CSA practices, with many of them converting to CSA of their own accord, and expressing their wish to learn more about CSA.

Following the successful acceptance of CSA by the planters, the next step for the project team was to create an innovative and financially interesting market for the CSA planters. On presenting the CSA project to the nearby high-end hotels, the hotel industry expressed their keen interest in purchasing the CSA-produced vegetables from the local farmers, and also to organise tours for the tourists to visit the CSA fields. The hotel industry saw this as a new branding opportunity to show their commitment to providing healthy foods to their clients, to demonstrate their own contribution to national sustainability efforts, to help the local communities, and also to offer their clients the opportunity to participate in these efforts.

The hotel industry agreed to pay a 10-20% higher than market price for CSA produced vegetables, and a platform was created between the nearby 5-star hotels and the CSA planters of Belle Mare, with the project team acting as a liaison and guide during the early stages of this partnership.

In order to consolidate the partnership further, the project team is developing a certification program for CSA-grown vegetables.

This initial collaboration has the potential to open up numerous other avenues for existing and potential stakeholders, for instance hotels could "adopt" small CSA farming communities and help them to develop further for mutual interest, hotels could organise CSA-linked activities to bring together families of tourists and CSA-farmers, such as culinary competitions, educational and hands-on CSA activities for tourists' children within the hotel gardens, pick-your-own CSA fresh produce in farmers' CSA fields, etc. Discussion are ongoing for the hotel industry to offer scholarships and grants to the children of CSA farmers to study at local Universities.

Apart from the tourism sector, CSA also has potential in other sectors. The project envisages developing platforms between CSA farmers and airlines and cruise ships to bring CSA-grown foods to travellers, between CSA farmers and hospitals and private clinics in the health sector to bring patients CSA-grown, healthy foods, and numerous activities associated with such partnerships. Ancillary activities associated with CSA production, for instance local manufacture and production of CSA inputs for farming, processing, marketing and distribution of CSA produce, etc can help create new opportunities for small and medium enterprises.

Conclusion

Climate Smart Agriculture can thus mark the genesis of an innovative socioeconomic sector for the national economy. Together with its environmental benefits, CSA has a multitude of advantages that can be translated into numerous opportunities at different levels of the economy, all of which can contribute to Government's promise to ensure climate-resilient food security for the citizens, while reducing the country's GHG emissions and meeting its international commitments.

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