

Introduction and Cultivation of Stevia (*Stevia rebaudiana*) in Nigeria for Achieving Sustainable Development Goals in Health and Food Security

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Abstract.

Increasing cases of diabetes mellitus at a very alarming rate globally have been a major concern at this present situation. This issue has become a subject of debate over the use of food substances with less or no calories to reduce the incidences of obesity and diabetes. Stevia rebaudiana is found to be a potential candidate which produce intensely sweet, non-caloric sweetener. The plant has the potential of replacing sugar as the leaves of the plant contain low-calorie but very effective glycosides (stevioside and rebaudioside). they are extracted as commercial products and are 300 to 320 times sweeter than sugar and can be safely used by diabetics. Nevertheless, most sugar consumers prefer low-calorie, natural sweeteners in their food to reduce the risk of cardiovascular disease, obesity, diabetes and tooth decay. This paper highlighted the cultivation of stevia rebaudiana through careful search of related literature on the subject. This paper is an attempt to look at the possibility of introducing and cultivating the crop in Nigeria to tapped the many benefits of the plant for economic growth, health benefits and food security. In the recent times the plant is acquiring consistently increasing economic interest because of the presence in its leaves a large number of sweet constituents. The extraction of sweeteners from stevia leaves is a growing business in industrial and commercial sectors worldwide. This paper is viewing the possibility of cultivating the product in Nigeria for revenue generation and improving health. cultivating stevia in Nigeria has the potential to foster economic development, promote environmental sustainability, improve public health, and contribute to the country's food security and agricultural diversification efforts.

Key words: *Cultivation, Sustainable Development, Stevia (Stevia rebaudiana), Health and Food security*

Introduction and Cultivation of Stevia (Stevia rebaudiana) in Nigeria for achieving sustainable development goals in health and food security.

Introduction

Diabetes is a global health issue, affecting countries like China, India, and the USA (Altaf *et al.*, 2021; Tabish 2007). In Bangladesh, 5 million people suffer from the disease, ranking among the top causes of death (Altaf *et al.* 2021). As dietary needs change with age, insulin production decreases, leading to complications. Stevia leaves help reduce diabetes (Mostofa *et al.*, 2010).

Insulin production, a hormone crucial for sugar metabolism, reduces with aging, leading to complications like diabetics' mealitus (Association,2008). Stevia leaves, with their antihyperglycemic, insulin-mimetic, insulinotropic, and glucogonostatic properties, play a crucial role in reducing diabetes (Shanak and Kadan ,2017; Islam *et.al.*2022). Diabetes and obesity are major public health problems due to their high prevalence, adverse effects on quality of life, and economic consequences (Chopra ,2020).

India is the world's diabetic capital, with 72 million cases in 2017(Kumar and Gandhi, 2018). With 500 million people expected to be diabetic by 2030, low-calorie natural sweeteners are preferred. Nigeria has the highest number of diabetics in Africa, with 1.7 million expected to increase to 4.8 million by 2030(Chinenye *et al.*2012). The rapid growth of society and population necessitates the use of plant raw materials in food, pharmaceuticals, and medicine (Begmatov *et al.*, 2022). Sucrose, an easily assimilated macronutrient, provides a quick energy source, causing rapid blood glucose rise. The number of diabetes cases is expected to increase to over 380 million by 2025.

Furthermore, this disease condition is very common, nowadays especially among the aged population and few younger ones that have congenital cases. According to WHO survey, approximately 500 million people worldwide will be diabetic patients by the year 2030(Saeedi *et al.*, 2019). Most sugar consumers prefer low-calorie, natural sweeteners in their food to reduce the risk

of cardiovascular disease, obesity, diabetes and tooth decay(Rahul Dev Gautam, Ravi Kumar, Ujala Kashyap, Pawan Kumar, Satbeer Singh, 2022).

In addition,low-calorie food, particularly for aged individuals with diabetes, is crucial for overall well-being. The rapid growth of society and population necessitates the use of plant raw materials in food, pharmaceuticals, and medicine. Sucrose, an easily assimilated macronutrient, provides quick energy and a rapid rise in blood glucose. The global diabetes epidemic is expected to increase by 2025 as stated by WHO.

Introduction and cultivation of Stevia (*Stevia rebaudiana*)

Stevia rebaudiana (Bertoni) is a plant native to Paraguay, South America, known for its low-calorie, effective glycosides(Yadav *et al.*, 2011a). These glycosides are 300 to 320 times sweeter than sugar and can be safely used by diabetics. Stevia is also used in the food and pharmaceutical industries as a natural sweetener with zero calories(Mehmed *et al.*, 2021).. The plant's high-potency low-calorie sweeteners, including stevioside, steviobioside, rebaudiosides A to F, dulcoside A, and steviol, have gained significant scientific and commercial interest worldwide. Stevia, rich in glycosides, has significant scientific and commercial interest due to its intense sweetness and acceptability over artificial sweeteners like aspartame and sucralose, which can cause fatal diseases(Hidar *et al.*, 2021). Stevia, a native herb from Paraguay, has low to moderate nutritional requirements due to its natural habitat's poor soil quality. It is grown commercially in Brazil, Paraguay, Central America, Thailand, Korea, and China, with China having 75% cultivation (Hossain M.F., Islam M.T., 2017). Stevia has been used as a sweetener for centuries, but poor seed germination makes propagation problematic(K. Ramesh, 2006). Out of the estimated 400,000 flowering plants, only 100 highly sweet compounds have been reported(Soejarto *et al.*, 2019). A Malaysian cost-benefit analysis compared sugar cane and stevia

Introduction and Cultivation of Stevia (Stevia rebaudiana) in Nigeria for achieving sustainable development goals in health and food security.

production costs, finding stevia production more profitable than sugar cane production, as shown in tables 1 and 2 below(Nordiana, *et al.* 2016).

Table 1: Enterprise budget for stevia cultivation

Item	Value per acre	
	RM	RM
Revenue		
25 tonnes @ RM 5 per kg		125,000
Variable cost		
Land preparation	2,000	
Seed	25,000	
Fertilizer	30,000	
Input	20,000	
Harvesting	500	
Labour	1,500	
Total Variable Cost		79,000
Fixed Cost	0	0
Total Cost		79,000
Estimated Profit		46,000

Table 2: Enterprise budget for sugarcane cultivation

Item	Value per acre	
	RM	RM
Revenue		
42 tonnes @ RM 0.50		21,000
Variable cost		
Land preparation	3,000	
Seed	5,400	
Cutting and transport	1,200	
Fertilizer	800	
Input	1,100	
Harvesting	300	
Labour	3,000	
Total Variable Cost		14,800
Fixed Cost	0	0
Total Cost		14,800
Estimated Profit		6,200

Fig.1 Cost benefit analysis of growing stevia and sugar cane compared (Nordina, 2016)

Stevia cultivation reduces soil erosion, nutrient leaching, carbon sequestration, water resource protection, pest tolerance, and wildlife habitat (Clemente *et al.*, 2021). It has applications in pharmaceutical, cosmetic, and nutraceutical industries. Japan commercialized crude extracts of *S. rebaudiana* in the 1970s, and over 150 countries have approved its use in foods and beverages (Samuel *et al.*, 2018)..

Climatic and soil requirement

Stevia thrives in well-drained, organic, sandy loam soil with a pH of 6-7, requiring consistent water supply and partial shade. Fertilizer requirements vary based on environment and soil type, with low nitrogen but high phosphorus and potassium requirements. The European Commission's Scientific Committee on Food addressed safety concerns in 1985 and 1999, recommending 70kg Nitrogen, 35kg Phosphorus, and 45kg Potassium per hectare(Yahaya, 2018).

The plant is known to be geographically widespread,(K. Ramesh, 2006). it grows well in semi -humid temperature with good light intensity. a temperature range of -6 °C to 46°C.(S. Singh *et al.*, 2021). The plant requires an annual average temperature of 310C with a rainfall of 140 cm per annum. When subjected to light and warm conditions it shows good seed germination(Singh, 2016). Stevia plants can be propagated from cuttings or seeds or by tissue culture. The plant is propagated using cloning through cuttings(Singh, 2016). It's a medicinal herb, with non-sweetening properties known as a natural sweetener plant with zero calorie content. With the over 346 million diabetic population across the globe, the sweetener becomes a remarkable alternative for sugar(Solanki and Singh, 2018). It is cultivated in march-April and June-July months in different parts of the World, harvesting is done after 75-90 days(Farhan *et al.*, 2020).Stevia has poor germination rate and therefore is grown faster from cuttings from mature plants than trying to sprout seeds. Pruning is an important practice as it maximizes leaf production to encourage its branching. Pruning is done at regular intervals and the leaves from them are harvested. the prunes can be rooted in moist potting soil to cultivate additional stevia plants for farm expansion. 8,000 to 10,000 seedlings can be planted per acre by a farmer. Micro propagation or propagation using plant tissue culture is needed using different explants of the plants like leaf, nodal and shoot tip explants. It was find out that optimized tissue culture

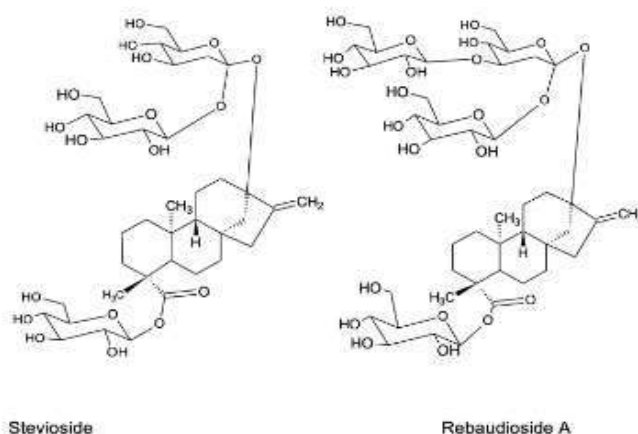
Introduction and Cultivation of Stevia (Stevia rebaudiana) in Nigeria for achieving sustainable development goals in health and food security.

conditions can produce quality rich material which could be used by pharma or herbal industry for developing any product (Solanki and Singh, 2018). Weeds are removed manually using hand and hoeing both the two methods are labour intensive and expensive. Weeding has been identified as the biggest field management concern in stevia cultivation (Azimah *et al.*, 2018). Stevia, a natural sweetener plant with zero calorie content, is cultivated in semi-humid conditions and requires an average annual temperature of 31°C. It is cultivated in March-April and June-July months worldwide, with harvesting after 75-90 days. However, it has a poor germination rate and requires regular pruning for leaf production. Due to its industrial application, weeding is a labor-intensive and expensive field management concern. Enhanced varieties are needed to boost steviol glycoside chemicals (Rahul *et al.*, 2022).

Phytochemistry and benefits of Stevia (*Stevia rebaudiana* (Bertoni))

Stevia rebaudiana, a plant rich in phytochemicals like austroinollin, β -carotene, and riboflavin, has industrial applications in beverages, energizers, and medicinal uses (Sathish Kumar Jayaraman, Muthu Saravanan Manoharan, 2008). Its high-sweet content and adaptability make it valuable for various countries. Stevia leaves contain eight sweet diterpene glycosides, including stevioside, steviolbioside, rebaudiosides, and dulcoside A, B. Stevia plants are essential for human nutrition and health (Singh *et al.*, 2015).

Narayana *et al.*'s 2022 experiment showed that sugar replacement with stevia did not affect milk fermentation characteristics, water holding capacity, or yoghurt color. However, carbohydrate content decreased and protein increased with sugar replacement. Steviol glycosides are now being used as food additives to reduce calorie-rich sugar consumption and diabetes (Farhan *et al.*, 2020).



Source (Kumar and Gandhi, 2018)

Stevia, a non-toxic, non-addictive, and non-mutagenic plant, contains compounds like Stevioside and rebaudioside A, which are used for treating hypertension, hyperglycemia, and anti-tumor activity. *Stevia rebaudiana* Bertoni is a zero-calorie sweetener with health benefits, including blood sugar regulation and anti-inflammatory properties. Stevia leaves produce diterpene glycosides, natural alternatives to synthetic sweeteners.

It possesses vasodilating, taste improving, sweetening, anti-fungal, anti-viral, anti-inflammatory, anti-bacterial properties and increases urination function of the body. In addition, it has been found to be non-toxic, non-addictive, non-carcinogenic, non-mutagenic plants in several countries like Brazil, Japan, and Paraguay (Bhutia and Sharangi, 2016). It is also used in the preparation of chewing gum, mouth wash, toothpaste, and many other herbal tea powders. It also improves insulin sensitivity and can be used for a dietary supplement. Along with these it can be utilized as food products such as sauce, pickles, ice-creams, ice-cakes (Singh *et al.*, 2007). Diterpene glycosides produced by stevia leaves are many times sweeter than sucrose. They are natural sources of non-caloric sweetener and alternatives to the synthetic sweetening agents that are now available to the diet-conscious consumers. The potential uses of

Introduction and Cultivation of Stevia (Stevia rebaudiana) in Nigeria for achieving sustainable development goals in health and food security.

stevia which produces stevioside, no-caloric sweetener that does not metabolize in the human body. they pass through the digestive process

without chemically breaking down, making stevia safe for those who need to control their blood sugar level(Yadav et al., 2011a).

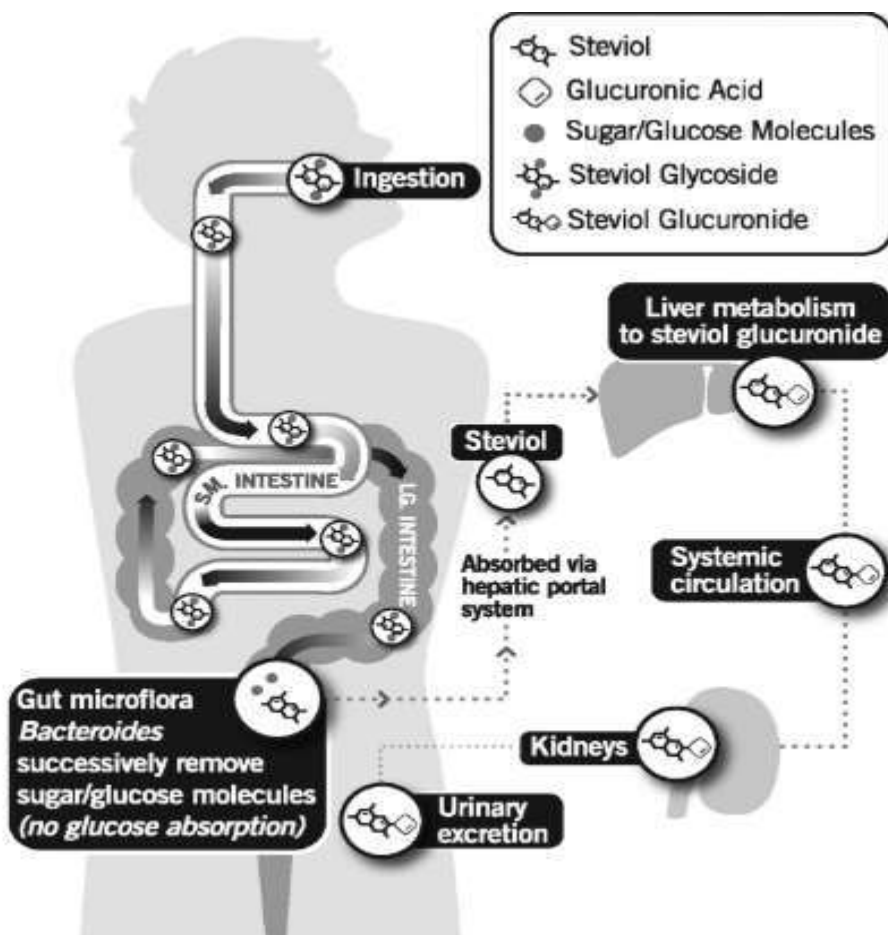


Diagram showing the metabolism of stevia through human gastro intestinal tract. (Samuel et al., 2018)

The phytochemicals present in *Stevia rebaudiana* includes austroinollin, β - carotene, dulcoside, nilacin, rebaudi oxides, riboflavin, steviol, stevioside and tiamin. The plant has important industrial

high blood pressure, and obesity but also can be used for the treatment of these diseases or preventions of their complications(Peteliuk et al., 2021). Steviol glycosides are undigested in the upper gastrointestinal tract. They are hydrolyzed or degraded only when they come into contact with microbiota in the colon that cleave the glysidic linkages, removing the sugar moieties, leaving behind the steviol backbone that is absorbed systemically, glucuronidase in the liver,

Many studies have shown that stevia leaf preparations as a natural non-calorie sugar substitute is not only for people with diabetes,

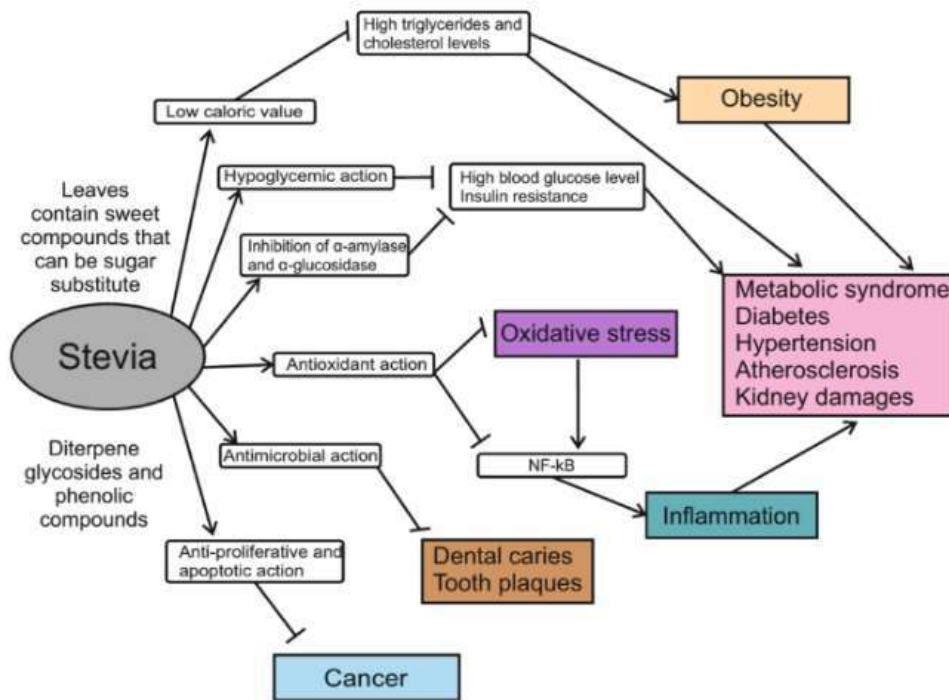
Introduction and Cultivation of Stevia (Stevia rebaudiana) in Nigeria for achieving sustainable development goals in health and food security.

and excreted via urine in humans and via feces in rats (Samuel et al., 2018). In Japan, cultivation of stevia is done as an alternative to artificial sweeteners such as cyclamates saccharine, which are suspected carcinogens. In US, stevia is mostly used as sugar substitute. About one-fourth teaspoon of the natural ground leaves is equivalent to one teaspoon of sugar (Kujur et al., 2010)

Stevia leaf preparations are a natural non-calorie sugar substitute used for treating diabetes, high blood pressure, and obesity. Steviol glycosides are undigested in the gastrointestinal tract and

hydrolyzed when cleaved by colon microbiota. Stevia is grown in Japan as an alternative to artificial sweeteners, and in the US, it is used as a sugar substitute.

Stevia, a safe, natural, and carbohydrate-free sweetener, matures in four months and is harvested every three months. It's used in creamy desserts, drinks, fruit salad dressings, yoghurt, and tea. Companies like Coca Cola and Pepsi use it. Kong Associates Shanghai has introduced over 100 improved castor seed varieties to Ghana.



Source : (Peteliuk et al., 2021)

Cultivation of stevia in Nigeria

Stevia cultivation is a profitable cash crop with low risk and high returns, provided high-quality leaves are produced, and success depends on careful selection of parents and population growth (Arpita Das, 2010). Stevia is commercially cultivated in China, Japan, Brazil, Canada, USA, UK, Spain, Belgium, Australia, South Korea, Thailand, Israel, and Taiwan. Its unique attributes make it a major producer and

exporter. Stevia is being promoted for bio-sugar production, with the World Health Organization predicting 20% sugar replacement by bio-sugars in the next few years. Stevia, a new crop, is gaining popularity as a sugar substitute. Nigeria, an agro-based country with diverse climatic conditions, can easily introduce stevia as an industrial crop (Zaman et al., 2015). Stevia grows well in open spaces with regular sunlight, and can be domesticated under various soil and climatic conditions. Nigeria's average rainfall of 381mm

Introduction and Cultivation of Stevia (Stevia rebaudiana) in Nigeria for achieving sustainable development goals in health and food security.

to above 4,064mm ensures better harvests than Europe and the US. Stevia thrives in temperatures between 28°C and 33°C. Stevia is commercially cultivated in China, Japan, Brazil, Canada, USA, UK, Spain, Belgium, Australia, South Korea, Thailand, Israel, and Taiwan. Its unique attributes make it a major producer and exporter. Stevia is being promoted for bio-sugar production, with the World Health Organization predicting 20% sugar replacement by bio-sugars in the next few years. Oluwatomi Olatoye, founder of Green Gold foods and beverages, believes that stevia could become the future sugar in Nigeria if properly utilized. With over 20 years of experience, Olatoye believes that stevia can reduce sugar levels in people with diabetes and can be grown in Nigeria's well-suited soil and climate. Stevia leaves can be harvested, dried, and ground into fine powder (Alimi, 2023)

As highlighted by Dr. Ibrahim Hussain, The Director General of the Research Development Council for Raw Materials (RMRDC), China, Japan, Brazil, Canada, USA, UK, Spain, Belgium, Australia, South Korea, Thailand, Israel, and Taiwan are among the countries where Stevia is grown for commercial purposes. Given our vast population of over 200million people and our varied climate, Nigeria cannot be an exception. The two largest manufacturers and exporters in the world are China and Japan. Stevia's unique qualities are the reason for its widespread appeal. In Most of the countries where stevia is promoted for use in the manufacturing of bio-sugar. The World health Organization supports the idea that bio- sugars will replace 20%of the sugar consumed in most nations during the next few years (Yahaya, 2018).

In 2017, Kong Associates selected adaptable varieties for commercial castor seed plantation development in the tropics, collaborating with RMRDC, Kong Associates, and CPPMAN for Nigerian trials. Kong is also promoting safflower and stevia in Ghana. The company has agreed to give us improved stevia varieties for multi-locational trials in the country. It is also planning

to send stevia agronomists to the country to direct planting operations. The company is interested in buying the leaves from and farmers that participate in the programme. This will guarantee the off take for the produce. In November, 2017, the trials were finalized and Kong Associates selected the most adaptable varieties to the tropics for commercial castor seed plantation development. In view of extant collaboration between RMRDC, Kong Associates and the Castor Producers, Processors and Marketers Association of Nigeria (CPPMAN); Kong gave Nigeria appreciable quantity of the seeds for multi-locational trials in Nigeria in 2017

According to Olatoye Stevia matures in four months and is harvested every three months. It is a perennial crop that produced for 4 to 5 years. It is safe, natural, zero-calorie and carbohydrate free sweetener. It has no side effect connected with sugar such as diabetes, obesity, high blood pressure etc. thousands of companies such as coca cola, Pepsi etc. are using stevia products. It is used as sweetener in creamy desserts, drinks, fruit salad dressings, yoghurt and tea(Olatoye, 2019). The council has been collaborating with Kong Associates Shanghai (China) Limited to promote the development of different varieties of the plant. The company has introduced more than 100 improved castor seed varieties from China to the Ahafo Region of Ghana for multi-locational trials. Kong is promoting safflower and stevia in Ghana, offering improved varieties for trials and sending agronomists for planting operations. They plan to buy farmers' leaves for offtake.

Economic benefits of growing stevia in Nigeria.

Nigeria's government should promote stevia cultivation, as it can create 1 million jobs in three years, including small farmers, plantation workers, and businesses, and attract foreign investors. Nigeria's stevia yields 2.5-3.628 tons per acre, generating N5,297,960.40 annually. It attracts online markets like Ali Baba and Pure

Introduction and Cultivation of Stevia (Stevia rebaudiana) in Nigeria for achieving sustainable development goals in health and food security.

Circle, and soft drinks companies like Coca Cola and Pepsi agents.

Conclusion and recommendation

Stevia is a healthier alternative to sugarcane, providing sweetening and a sweeter taste. It is 300-320 times sweeter than sugar and can be grown on a large scale for easier production and cheaper pricing. Stevia cultivation is being promoted in countries like the USA, Japan, and developing nations like India, Malaysia, Indonesia, Paraguay, Bangladesh, and Brazil. Proper cultivation techniques and climatic and soil requirements are essential for better yield and profitability. The government should support the cultivation of vita crop by providing loans, subsidies, research, marketing boards, and industries that utilize the product as raw material.

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Xinjuan Xu et al 2024 Identification of geographic, climatic, and soil factors dominating Stevia rebaudiana yield and quality Industrial crop and products volume 214 pp 1-5

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