Ginger Production Constraints and Future Perspectives in Fiji

Kajal Kamal Sharma, H. K. Sachan* and Deeksha Krishna

College of Agriculture, Fisheries and Forestry, Fiji National University, PO Box 1544, Nausori, Fiji

ABSTRACT

This paper talks about the constraints of ginger farming and its future perspective in Fiji. Ginger is recognized as a significant product in Fiji due to the potential the crop has for food, income benefit, and providing work to the farmers. However, the industry is facing many drawbacks. The main ginger farming constraints in Fiji viz. access to quality planting material, access to water, loss of expertise, soil-borne pathogens like Pythium soft rot and nematodes infestation, pest infestation whereby the presence of scale insect intercepts with the requiring quarantine interventions, unsatisfactory result of pre-planting hot water dip treatment, land and differentiation in rural Fiji (Land tenure) and exporting fresh ginger to high market prices explains how the local ginger produced are not attaining high niche markets.

Keywords

constraints, farming, Fiji, ginger, production

1. Introduction

Fiji is a country in the South Pacific Ocean composed of 332 islands of which only 110 are inhabited [22]. The country has a total area of 18,270 km². The two major islands, Viti Levu and Vanua Levu, with total areas of 10,429 km² and 5,556 km², represent 57% and 30% of the total area of the country respectively (Fig.1). Two smaller islands, Taveuni with a total area of 435 km², and Kadavu with a total area of 408 km² account for a further 4.6% of the land area, and most of the remaining islands are very small. For administrative purposes, the country is divided into 14 provinces and 1 dependency (Rotuma). The agricultural area, which is the sum of arable land, permanent crops, and permanent meadows and pasture, is estimated at 425,000 ha, which is 23% of the total area of the country. In 2013, the total physical cultivated area was estimated at 250,000 ha, of which 66% (165,000 ha) consisted of temporary crops and 34% (85,000 ha) of permanent crops [12]. The islands form a group of high islands of volcanic origin, with barrier reefs, atolls, sand cays, and raised coral islands. Both Viti Levu and Vanua Levu are mountainous, with peaks rising to 1,323 m and 1,032 m above sea level respectively. The uplands of both islands were formerly covered in tropical rainforest, but much of this has now been replaced with secondary forest and grassland on the lower slopes. Farmland occupies the most flattish lowland, and large areas on both islands are under cultivation for sugarcane. In fact, more than half of the cultivated area consists of three crop types only: coconuts (26%), sugarcane (17%), roots, and tubers (10%) [12].

Ginger (Zingiber officinale Roscoe) is an herbaceous plant native to south-eastern Asia [21,3,37]. African ginger, Black ginger, Cochin ginger, GanJiang, Gegibre, Ingwer, Jamaican ginger, and Race ginger are all alternate names for ginger. Over 25 variants are produced worldwide [2]. Ginger is a cash crop that assists in the life and economic development of many ginger growers in the country. In India, China, Africa, Jamaica, Mexico, and Hawaii,
it is widely farmed [40]. It is a plant that has been used in folk medicine in Southeast Asia, Africa, China, India, and Jamaica for centuries [2, 21, 38]. India is the world’s largest producer of ginger, followed by China, Indonesia, Nepal, and Thailand, however, the most expensive and premium types originate in Jamaica, Australia, and South India [18, 1, 2].

Figure 1: Map of Fiji [51]

Ginger is utilized in a variety of goods and is grown as a fresh vegetable as well as a dried spice. It is a staple in the spice industry and has been used to flavor a variety of items. It is cultivated for its pungently scented subterranean stem, which is a valuable export crop due to its powder, oil, and oleoresin, all of which have food and medicinal properties [41]. Apart from its tart flavor, the fresh rhizome has a significant amount of protein (2.3%), carbs (12%), lipids (1%), minerals (1.2%), fiber (2.5%), and moisture (81%) [21]. Dried ginger is an anti-inflammatory and antimicrobial ingredient that can be used to treat malaria, asthma, and headaches. There are numerous ginger cultivars, with China determining the best cultivar variety [36]. Nevertheless, Fiji grows only a few kinds. The primary cultivar grown is called ‘Queensland’, which was introduced from China. This is the most frequently cultivated cultivar in Fiji, where it is referred to as red or ‘Queensland pink’ (Photo 1). Recent advancements in Australia include the introduction of a tetraploid variety of ‘Queensland’ ginger known as ‘Buderim Gold’, which produces better yields and has larger rhizomes [29]. Although Fiji received tissue cultivated Buderim Gold flora, this type is not commercially farmed there [44]. Additionally, Fiji grows the ‘Canton’ variety, sometimes called ‘white’, for the sparkling market (Photo 2).
Ginger production is labor- and capital-intensive, in addition to being a long-season crop that takes approximately 5–10 months from seeding to harvesting [32]. The crop has been seriously harmed by a variety of illnesses in the field, warehouse, and market [21,39]. Post-harvest losses in ginger are a major concern, as the valuable yield is wasted owing to crop production neglect and storage in underground pits and open piles at various phases. The purpose of picking this research was to aid in the understanding of ginger production, as there are few studies and research on ginger cultivation in Fiji.

2. Background of Ginger Production in Fiji

Ginger production began in Fiji in the 1950s. It is referred to as a priority commodity due to the potential for food and income benefits while also employing local farmers. There are currently 717 registered ginger growers in Fiji, 611 of them are located in the Central Division, which includes the areas of Navua, Namosi, Naitasiri, Rewa, and Tailevu. Ra in the Western Division is home to 106 farmers (Fig.2). A few farmers have established themselves in Kadavu, Lomaiviti, and Vanua Levu. These farmers cultivate ginger for both domestic and international markets [16].

By the mid-1980s, ginger had surpassed sugar as Fiji’s second-largest agricultural export, with over 2300 tonnes of mature sparkling ginger sea-freighted to North America each year. Today, Fiji’s export market recognition is limited to a small seasonal niche for newborn ginger. Parallel to the clean export enterprise, processed ginger has emerged as the enterprise’s leading zone, offering the greatest potential for growth [52]. Ginger cultivation requires less labor because it may be harvested in six months, compared to other root crops, and can yield values of up to 95 cents per kg for green ginger and F$5 per kg for mature ginger. Ginger has a market price of F$2.79 per kg in June 2020, according to Fiji Agriculture [13,15]. Apart from the benefits, this industry faces numerous challenges, including access to high-quality planting materials, water scarcity, loss of expertise, soil-borne pathogens such as *Pythium* soft rot and nematode infestation, pests such as scale insects, unsatisfactory results from pre-planting hot water dip treatment, land tenure issues related to land and differentiation in rural areas, and exporting of high-quality planting materials. The Fijian government is placing a greater emphasis on fostering an investment-friendly climate that fosters growth, excessive boom, and increased returns. This comprises the construction of critical infrastructure, the expansion of market access, the improvement of data flows, the examination of legislation, and the elimination of limits on traits [50].
3. Current status of ginger production in Fiji

Ginger has long been recognized as a key commodity in Fiji due to its potential for food and financial benefits, as well as employment for local farmers. Fiji Ginger is considered to be among the best by worldwide standards. Due to its superior quality, it provides an opportunity to increase local ginger production and capitalize on growing demand (Table 1).

| Year | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|------|------|------|------|------|------|------|------|------|------|------|
| Area (ha) | 69 | 78 | 96 | 171 | 161 | 244 | 262 | 303 | 395 | 313 |
| Yield (t/ha) | 33.61 | 33.22 | 34.70 | 34.55 | 34.49 | 25.04 | 24.99 | 25.03 | 25.05 | 30.03 |
| Production (t) | 2319 | 2591 | 3331 | 5908 | 5553 | 6109 | 6548 | 7585 | 9894 | 9398 |

Additionally, the Government recognized the promise of ginger and its potential for income and food security, and as a result, from no allocation in 2011 to F$1 million in the fiscal year 2017–2018, the Government allocated F$1 million [48]. The Fijian government has designated fresh baby ginger as a high-priority commodity for access to Australian markets. Fiji sends fresh mature (adult) ginger to several nations, including New Zealand, Canada, and, on occasion, Hawaii, for direct sale in supermarkets. Fiji historically shipped fresh mature ginger to the United States, but the practice was discontinued due to a decline in pricing as a result of China’s access to the US market for ginger. This has increased the importance of the Fiji Government’s access to Australia for baby ginger. From Fiji to Australia, fresh mature ginger for further processing is currently permitted subject to particular import regulations. Fiji also exports processed ginger to Australia (sugar-preserved, brine-preserved, and ginger powder, among others) [47].
4. Methodology
A qualitative survey method using literature reviews, case studies, journals, and personal interviews were administered to collect the required information which was used to gain an in-depth understanding, situate the research in an existing body of work, and evaluate trends within a research topic of ginger farming constraints and future perspective in Fiji. The data collected were summarized and discussed using a descriptive approach.

5. Constraints Limiting Fijian Ginger Production
Major constraints limiting Fijian ginger production can be classified into two categories: biological or environmental and socioeconomic.

5.1 Biological or Environmental Constraints
5.1.1 Quality planting material
Farmers producing ginger typically for subsistence farming usually find it difficult to get a sufficient quantity of healthy planting material as they tend to sell their immature ginger for quick returns so less immature ginger leads to lower seed material being produced. Therefore, when it comes to replanting ginger, they do not have healthy viable seeds. Other major ginger farmers face similar problems as there is no independent seed material production to ensure continuous seed supply [11]. Advanced method of seed production like hydroponics in a greenhouse ensures that the planting materials are readily available, have a high yield, free from bacterial wilt, and have consistent supply as the conditions are controlled in a greenhouse. This led to the production of planting material throughout the year.

5.1.2 Climate
Ginger is a crop that needs a considerable amount of rainfall. Since ginger farms are located on both western and central divisions of the main islands the amount of rainfall differs in each division. Farms located in the central division have ongoing water availability, however, excess amount of this rainfall has negatively impacted the ginger production due to compounding pathogen issues thriving in this condition. On the other hand, in the western division whereby lower rainfall is experienced becomes a favorable condition which greatly reduces pathogen issues during production. But the amount of rainfall received is not sufficient to sustain the production therefore irrigation becomes necessary increasing the cost for small and medium farmers [11]. An experiment was done to find out the tolerance of two different ginger species with different water stress and results revealed that the amount of water use was higher under well-watered treatments as compared to stress treatments for both African ginger and commercial ginger. For commercial ginger, the fresh and dry rhizomes were higher in contrast to African ginger in both wet and dry seasons. It showed that the treatments containing high water content were more affected and severe water stress reduce ginger rhizome yield in both commercial and African ginger and commercial ginger is less sensitive to water stress [17].

5.1.3 Soil-borne pathogens and nematodes
Ginger plants require mildly acidic soils for healthful boom and rhizome production. Soil pH between 5.5 and 6.5 is recommended. If the soil pH is just too high, it’s miles too alkaline; if it’s miles too low, it’s miles too acidic, and could intrude with the ginger boom. Lower the soil pH via making use of composted manure, or grow the pH with calcium carbonate or dolomite to reap the most useful ph. Good smooth soil is also critical for healthy ginger. Soil is to be sanitary and free from pests, or fungal pathogens, and parasites, including root-knot nematodes [44,27].
As per the evidence collected by Fiji and Australia, *Pythium* soft rot is one of the major pathogens affecting ginger production due to prolonged periods of wet overcast weather and conditions where soil remains saturated (Photos 3 and 4). Nematodes are also another cause of decreased production of ginger as these are introduced in planting material that is brought in to be used [11,45,16].

As per the pest and disease survey carried out by the Australian Centre for International Agricultural Research on proving farming systems for managing soil-borne pathogens of ginger in Fiji and Australia. Evidence composed supports the association of *Pythium* Soft Rot with prolonged periods of wet, overcast weather and situations where rainfall is high and soil is saturated with water. Ginger produced in Fiji and Australia which were *Pythium* detaches were grown well in high temperatures [42]. Observations at the etiology of rhizome rot of ginger are offered for Fiji and Australia. In Fiji, the disease commonly develops during hot, wet situations in March and April, and often reasons losses of more than 50% in seed vegetation. The disease became determined for the primary time during the moist summertime of 2007–08, nearly destroying the immature ginger crop in one subject and causing 8–30% losses in other fields [41].

Photo 3: Ginger rhizome with severe soft rot, *Pythium* sp. affecting the young buds and shoots (Source: [7,30])

Photo 4: Ginger with soft rot, *Pythium* sp., showing drying-up of the leaves and collapse of the plants (Source: [30,34])

Photo 5: Root-knot nematode, *Meloidogyne* sp., on ginger (Source: [30,34])

Photo 6: Rhizome infested by the burrowing nematode, *Radopholus similis*, showing brown sunken rots, and decay of the buds (Source: [6,44])

Photo 7: Ginger rhizomes damaged by the burrowing nematode, *Radopholus similis*, and rejected at harvest (Source: [6,44])
Studies on the role of rotation crops in managing plant-parasitic nematodes on ginger in Fiji, there were two important nematode pests found affecting ginger, namely root-knot nematode (Meloidogyne incognita) and burrowing nematode (Radopholus similis) (Photos 5–7). These types of nematodes are known to be found in areas where ginger production is in the mass population. The study concluded with crop rotation practice every three years with crops like cassava and taro are brilliant rotation in managing these parasitic nematodes damage on ginger [46]. According to the review of import conditions for fresh ginger from Fiji by the Australian Government Department of Agriculture, Radopholus similis is generally associated with plant roots [10].

5.1.4 Insect-Pest Infestation

Even though there is no major pest of ginger reported in Fiji which is significant to affect the production of ginger. The problem arises when these ginger does not get accepted for export. Scale insects present on the ginger intercepts with the requiring quarantine interventions [11]. These scales feed the sap of both rhizomes in the field and during storage. Symptoms shown are shriveling, desiccate and lastly fail to germinate. White-colored scales are seen on rhizomes during the early stage of infestation while advanced stage they gather near growing buds. A severe infestation will lead to its buds shrivel and eventually lead to the drying of the entire rhizome. This scale is mostly transferred from one place to another via infected rhizome and farm tools [20].

5.1.5 Land Degradation

The ginger/root crop rotation exposes the crop for extended periods. Immature ginger soils are primarily prone to erosion, as immature ginger is harvested during the wet season and farmed in rotation with cassava. Available evidence indicates that land degradation in the region is not only severe but also rapid. Without soil conservation measures, a typical ginger farm in Waibau discovered soil losses of approximately 85 t/ha/year and 135 t/ha/year for ginger planted on slopes of 12 to 15° [4]. These rates of soil loss are far more than the maximum “soil-loss tolerance” factor recommended for tropical climates. The area is characterized by rill, gully, and sheet erosion [19].

5.2 Socioeconomic Constraints

5.2.1 Loss of expertise due to the attitude of the farmers

Due to the rural to urban drift, the younger generation is not interested in continuing their family business of ginger farming [11]. This move has resulted in a few numbers of farmers. As the ginger growers are retiring this leads to a decrease in the expertise required for ginger production. As per the Australian ginger industry on the Overview of market trends and opportunities, the key problem facing the ginger growing industry is, the growers are aging and retiring from the industry there are no new growers to replace them. This allows the industry to have an uncertain future as growers are aging [8].

5.2.2 Exporting fresh ginger to high market prices

Fiji faces constraints in achieving Global GAP or organic certificates. The use of chemical herbicides and less technical awareness in regards to integrated pests and disease management exists. The method of post-harvest handling and timing of harvesting practiced by growers are not appropriate as these practices hinder in achieving the certification for exporting ginger to high market prices. Those farmers producing organic products under fair trade produce in developing countries had an advantage in attaining niche markets, however, these markets are fairly small in absolute volume terms. “Most registered suppliers are only finding a fair trade market for a relatively low percentage of their total output, with the balance being sold into the conventional market [9]”. The growth in demand for other fair trade products would be taken by those that are already in the fair trade program which becomes
impossible for the new generation to enter the fair trade. Exporters who are producing products organically face the same issues as those producing conventionally as the transition to organic farming itself becomes a constraint, especially when a country is developing. These countries find it difficult to control a high level of rejection to meet the standards as the organic scale farming is small and cannot compete with the oversupply by other countries [9].

5.2.3 Unsatisfactory result of pre-planting hot water dip treatment

As per the ginger growing guide, it states the application of the pre-planting hot water dip treatment is an important stage in ginger farming. Dipping of planting materials before planting in a hot water for 52 °C for 10 minutes to control nematodes. This however became an issue to the growers as they find it difficult to meet the specification in regards to the degree of accuracy. Due to this, some farmers believe this hot water treatment is not necessary as this technique is not variable [11]. A survey carried out at the processing plant in Suva on the Fiji ginger farms and rhizomes, showed that burrowing nematode (*Radopholus similis*) was the cause of damage to rhizomes and losses made in the crop in districts of Veikoba and Muanaweni. *R.similis* were “isolated from both small water-soaked lesions and rotted sections of rhizomes, and a pathogenicity experiment revealed that the nematode also invaded the base of shoots, causing collapse and death of plants 20 weeks after inoculation”. It was also concluded that the reason for several farmers continuing to have nematode infestation is because and ginger growers fail to meet the recommended hot water treatment being applied correctly [43,49].

5.2.4 Land and differentiation in rural Fiji (Land tenure)

Land in Fiji consists of freehold land, country land, and local land. Out of those kinds, about 9% of the land is below freehold tenure, about 3% is country land, and the last 88% of the land is Native land [38]. Fiji’s land tenure system complicates the farming practices as the majority of the farming areas are under native land. Expiring of land lease especially for farmers who are growing ginger in sugarcane fields. Therefore, when sugarcane farmers’ lands were expired the ginger farming also faced the loss of some farmers [23,24]. Also, farmers are hesitant to invest in native land which does not have long-term leases. According to the FAO Commodities and Trade Paper on the market for non-traditional agricultural exports stated that various developing countries have tribal or leasehold land which becomes an issue in terms of security towards the farmers.

6. Discussion

Ginger growers tend to sell their immature ginger for quick money therefore, later when they require mature rhizome as seed for planting it becomes unavailable to them. Due to high amounts of rainfall in the wet ginger growing zones, the soil conditions become saturated compounding pathogen issues. On the other hand, dry areas do not receive sufficient rainfall forcing growers to carry out irrigation. This increases the cost of production. Growing mature ginger in dry areas and immature ginger in the wet zone can help minimize this problem. Loss of expertise arises when growers get aged and the younger generation is not willing to take up ginger farmers to fill in the gap for retired growers. Soil-borne pathogens such as *Pythium* soft rot and nematode infestation are major problems facing the ginger industry. Pest infestation such as scale insects particularly found on rhizomes decreases the quality of ginger. Due to unsatisfactory results of pre-planting hot water dip treatment by farmers for planting materials growers believe that hot water treatment of 51 °C for 10 minutes does not work but many are not following the specification where the accuracy of the temperature 51 °C for 10 minutes is not maintained. Land and differentiation in rural Fiji (Land tenure) whereby farmers especially growing ginger in dry areas experience the issue of land expiry as many of these farms are native land which is leased to them. Exporting fresh ginger to high market prices whereby
Fiji ginger is not able to get high prices due to the quality of rhizomes produced. Established of Kaiming Agro Processing Ltd (KAPL) by European Union to ensure quality is maintained by avoiding post-harvest loss through poor harvesting and handling practices. Sustainable ginger farming practices are important so as the production level can be maintained over a long period and ensure the land is not degraded.

7. Future Perspective

Ginger farming has huge potential in local and overseas market, however, the challenges faced by ginger growers may vary from the areas in which farming are being practiced. Soil-borne pathogens such as *Pythium* soft rot and nematodes are the major concern in the ginger industry. Research on breeding new varieties of ginger has been successful in attaining significantly larger underground root Rhizome (Buderim Gold) at the QPIF Maroochy Research. However, to curb the pest and disease problem the Australian Ginger Growers Association (AGGA) has expressed a strong interest in further research and development into disease-resistant varieties [8]. Other suggestions include a long break from ginger, so an extended pasture break could break the cycle of soft rot and nematodes. More work is therefore required to demonstrate the economic benefits of alternative ginger farming systems and measure impacts on rhizome yield and quality [19]. The chemical use of fungicide to control soft rot in ginger has been encouraging but there is a need to carry out further research on the harmful effects of using fungicide on the environment and human health [35]. Ginger production system whereby ginger follows a rotational system in Fiji as ginger – taro – cassava – fallow – ginger has been the trend for the last 10 years and researchers are revising the practice to be more convenient and profitable for the farmer. Fiji expressed an interest in assisting with additional experimental investigations on *Radopholus similis*. MoA Research, on the other hand, currently lacks viable cultures of *Radopholus similis* isolated from banana or ginger. Formerly maintained cultures at the Koronivia Research Station were donated to the University of the South Pacific in Suva several years ago, although it is believed these cultures no longer exist. If cultures of *Radopholus similis* are required for comparable investigations, the nematodes will likely be collected from the sector. After completing their aim during the harvesting season, more farmers in Serua and Namosi are expected to cultivate ginger [5]. If the rate of land degradation in ginger-growing regions is to be stabilized at an economically viable level, sustained action must include a balanced combination of appropriate “carrot and stick” tactics and information distribution. Concentrating exclusively on one thing may be useless, as they all reinforce one another.

8. Conclusion

Fiji’s thriving industry like ginger faced many challenges must overcome constraints to reach its maximum productivity. Even though growers have issues in having access to quality planting materials, access to water, loss of expertise, soil-borne pathogens, and nematodes infestation, pests, the unsatisfactory result of pre-planting hot water dip treatment, land tenure issues relating to land and differentiation in rural areas and exporting of quality fresh ginger to high market prices. Establishment of independent ginger seed production units consistently supplying pests and disease-free planting material, adequate rainwater management in the dry area, and cultivating immature ginger in wetter areas. Loss of expertise required for ginger farming can be curbed through changing the mindset of people about farming, creating awareness on the importance of the ginger industry, its profitability under proper skills and management. *Pythium* soft rot and Nematode infestation can be reduced to a great extend if the basic rules for ginger farming are strictly followed. Creating awareness to maintain the correct temperature for a length of time to kill nematodes is important and technologies that farmers can use to ensure that this technique is successful. Since the majority of cane growing areas are under native land, expiring of the land lease for sugarcane areas means the
ginger farming in these dry areas is also affected. Extension of the longer lease period for farmers will encourage farmers to invest in farming and this will have a positive impact on the production of both sugarcane and ginger. By addressing these key issues, Fijian ginger can achieve higher prominence among world leaders.

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