Impact of the Quinoa Seed Plant as an Alternative Ingredient in the Manufacturing of Stock Feeds in Zimbabwe

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Abstract

The paper assessed the impact of the quinoa seed plant as an alternative ingredient in the manufacturing of stock feeds in Zimbabwe. The most serious threat to food security in Africa is the low production of conventional cereals such as maize, wheat, and soybean, which has harmed the stock feed production sector. The study reviewed relevant literature on the fundamental role of quinoa as an alternative in stock feed production. A qualitative research methodology was employed in the study, in which desktop review and research were used to generate findings and answer the major study question. Reports, peer-reviewed articles, blogs, and other sources on the web were assessed in line with the study phenomenon. The major findings were that quinoa (Chenopodium willd.) greatly impacts the stock feed manufacturing industry in Zimbabwe based on its highly nutritious value, cost-effectiveness, and resistance to harsh climatic conditions. The major challenges that were identified that hinder the use of quinoa in stock feed production were the unavailability of registered pesticides and weed control measures, a lack of knowledge, and the unavailability of quinoa seeds locally. The study recommended that stock feed companies in Zimbabwe should invest resources in growing quinoa seed plants to improve the quality of the stock feeds.

Keywords

Quinoa Seed Plant, Manufacturing, Stock Feeds, Alternative

1. Introduction

This paper navigated through the impact of quinoa seed plants in the manufacturing of stock feeds in Zimbabwe. Courtesy of the drastic climatic changes in Southern Africa and the increasing threats of food insecurity in Africa, the adoption of quinoa seems to be a panacea for economic growth and improved livestock production in Africa. Climatic changes in the past years have negatively impact the availability of cereals such as maize, wheat, and soya beans that were historically used in the manufacturing of stock feeds.

2. Background

Quinoa (Chenopodium Willd.) originated several years (more than 5,000 years) ago, and it originated in Lake Titicaca in Peru and Bolivia. Quinoa 2013 International Year (2013) states that the plant was cultivated during pre-Columbian civilizations, although it was later replaced by cereals that were staple foods, and these included maize among others. The historical background of the plant shows that it was previously used as the main source of food, with its leaves and seeds being used for human and animal consumption. The macro- and micromineral components of quinoa varieties in line with using them as an alternative in the manufacturing of stock feeds were analyzed in terms of their impact [1].

The quinoa plant is characterized by small green clustered flowers and small fruits with a single seed that was discovered in South America in pre-Colombian times [1]. Ironically, the plant served as a staple food in South America for many years and was later replaced by cereals, and surprisingly, the world has again realized the importance of this plant based on the shortage of cereals and the drastic climatic changes the world is experiencing. Quinoa can be described as the mother of all grains, and even today the crop can be ground into flour, boiled like rice, used in soups, and prepared for rice. Moreso, the plant can also be used for livestock feed and alcoholic beverages. Quinoa is high in proteins (amino acids) and other nutrients as compared to other cereals such as maize, soya beans, and wheat [2].

High demand for livestock feeds in the past decade was noticed across the globe, particularly in US markets and Europe [3]. FAO’s report for 2021 projected that the increase in demand for stock feeds would mean that by 2050, food production should have increased by 60%, which implies that animal-based protein production should rise in tandem with population growth demand [1]. FAO's (2021)’s projections also show that meat production will escalate by 70%, 90% for seafood products, and 55% for dairy products. This implies that the shortage of cereals will hamper stock feed producers' efforts to meet the demand for livestock feed. Based on the USA animal feed market by raw materials, it has been shown that raw materials such as soya, corn, maize, and wheat are in short supply, giving quinoa a place to be a favorable substitute in the manufacturing of stock feeds.

The COVID-19 pandemic has been regarded as a key factor that caused the increasing shortage of raw materials for the manufacturing of stock feeds. Before the COVID-19 period, demand for stock feeds was stable, but the pandemic

gravely created a huge shortage of raw materials (cereals) and exports were banned. FAO states that countries such as Romania banned the export of cereals such as soybeans, bakery goods, flour, barley, and wheat to non-European countries, of which Africa is not excluded [4]. The transportation sector, which also ferries raw materials, was badly affected by COVID-19, resulting in further disruptions to the supply chain system. Notably, lamb production, piggery projects, and beef farming have been affected, and stakeholders have called for measures to address the crisis. Because of this, analysts predict a decrease in the use of these main cereals, for which Quinoa has emerged as a suitable substitute due to its high nutritional content and resistance to adverse weather conditions. Countries such as Malaysia, Thailand, and the Philippines have recorded a decline in the demand for cereals by 6% [4].

The adoption of growing quinoa has been influenced by the high shortage of stock feeds on the market, particularly in Southern Africa, where its prices have ballooned in light of the shortage of raw materials. Population growth across the world, urbanization, and rising incomes influenced the escalation of the demand for livestock products in Africa [5]. Africa and Asia may record a 200% increase in demand for stock feeds by 2030 [6]. The correlation between demand for livestock products and human health has opened up new livestock-related businesses. In the same vein, these new enterprises can transform the lives of low-income families in that they can purchase better food for their families at affordable prices. The Global Nutrition Symposium looked at the implications of livestock feed shortages in Ethiopia, Burkina Faso, and other African countries and realized the need to reinvent the intensification of growing quinoa plants to substitute cereals that are not readily available [7]. Additionally, the rampant demand for livestock feeds has influenced the rise of food prices, coupled with the disruption of the supply chain for wheat and maize due to droughts.

Despite the resistance of quinoa varieties to differing temperatures, the plant can be produced at low prices as compared to other cereals that are imported. It was discovered in a study that early quinoa adopters and state projects on quinoa cultivation have demonstrated the potential of quinoa as an innovative alternative in livestock feeds, as well as its high nutritional content and adaptability to varying agricultural conditions [8]. The price of maize has risen in Africa based on its short supply, and this has hard-hit the availability of maize as an ingredient in stock feeds [9]. Coupled with the continued droughts and incessant rains in Africa, maize production has lowered, resulting in a rise in the price of staple food, and this has caused a triple effect for stock feed producers, who are now forking out more money to purchase the cereal. For example, Africa Science Focus reported that maize buyers and sellers in Nairobi, Kenya, reported that the price of maize increased based on the changes on the global market. Though research reveals that higher carbon dioxide levels can boost maize yields [6], this paper takes a new route in assessing whether the adoption of growing quinoa plants can be the only solution to the food insecurity that has negatively impacted the unavailability of ingredients and the high prices of stock feed.

Zimbabwean market has been hard hit by the shortage of stock feeds, in which poultry and pig farmers have been stuck for several years since the prices of the stock feeds have gone too high, leaving the farmers with minimum profits [10,11]. In Zimbabwe, maize is used as the major raw material in the manufacturing of stock feeds while also being the staple food. In 2020, the price of maize rose by 10%, so stocks at stock feed suppliers ran low. Zimbabwe is still in its infancy stages to benefit from Quinoa farming (small grain farming) which was introduced by Sizimele Consortium Zimbabwe Resilience Building Fund (ZRBF) in 2017 that imported the seed from South America and the first farmers started the project in Matobo district in 2019 [12]. It is reported that over 3000 farmers in 18 districts in Zimbabwe started to benefit from the project sponsored by Sizimele Consortium project. Most importantly, the grain has a very good market in neighboring Zambian companies.

Additionally, series of droughts in the past decades and climatic changes (erratic rainfalls and high temperatures) have also contributed to the scarcity of maize as a raw material in the manufacturing of stock feeds [13,14]. In the same vein, the famine Early Warning Systems Network (FEWSNET) warned in 2020 that the national cereal supply in Zimbabwe will drop significantly to unreasonable levels, which implies another outcry to stock feed producers and suppliers. Therefore, this paper sought to establish the place of quinoa seed plants as an alternative raw material in the production of stock feeds in Zimbabwe and Africa at large.

3. Research Question

The paper sought to answer this question:

- How effective is the use of quinoa seed as an alternative in the manufacturing of stock feeds in Zimbabwe?
- Which challenges can impede the use of quinoa seed as an alternative ingredient in the manufacturing of stock feeds in Zimbabwe?

4. Literature Review

4.1 Quinoa Seed

Quinoa seed is defined as an annual herb that belongs to the Amaranthaceae family and originated in the Andean highlands of South America; its seeds and leaves are used for both human and animal consumption (Harvard School of Public Health, 2021). Quinoa is described as the world's healthiest food based on its high nutritional value in proteins, fiber, and amino acids. Quinoa is an edible seed that can be found in different colors such as black, red, white, and

yellow. Additional minerals that can be found in quinoa include manganese, magnesium, folate, thiamin (vitamin B1), and phosphorus [15].

4.2 Stock Feeds

Stock feeds as animal food that is used to feed animals, particularly livestock. For this paper, stock feeds are for pigs, cattle, chickens, horses, and dogs [7]. In line with this definition, the use of quinoa seed as an ingredient in the manufacturing of stock feeds will determine the quality of the feeds for the animal's health.

4.3 Impact of Quinoa Seed as an Alternative Ingredient in Stock Feeds Manufacturing

The benefits of quinoa to livestock feed manufacturing are exciting for countries that are facing an acute shortage of cereals such as maize and wheat. Quinoa has been widely accepted as an effective replacement for conventional feedstuffs based on its high nutrients and low production costs as compared to soybean, wheat, and maize [16]. According to research, quinoa's high nutritive value makes it ideal for ruminant feed and pigs. Research evidence has also shown that quinoa can replace clover by 45%, thus improving the overall health of livestock. Notably, a study that was published in the Journal of Animal Physiology and Animal Nutrition found that quinoa contains saponin, which has a hugely positive effect on the performance of pigs. South American quinoa hull meal and Danish quinoa were found to be more beneficial to the health of pigs [16].

Quinoa seeds can drastically improve the quality of meat. Studies found out that quinoa is a perfect source of proteins, unsaturated fatty acids, carbohydrates, fiber, and others as compared to other cereals [17,18]. In Japan, quinoa-fed livestock, such as quails, were found to have higher quality meat and a longer meat shelf life. Additionally, quinoa can be used as mixed feed for poultry and prevent or delay the oxidation of meat's lipids [16]. Quinoa has gained global appeal based on its high nutritional content [17,19]. Hence, quinoa seeds can promote the stock feed industry based on the benefits of quinoa to animal health as well as the processing of modern food products.

Quinoa can be highly accepted in Zimbabwe farming regions, particularly those that receive low rainfall as well as those that experience high temperatures since the crop is drought resistant. Sizimele Consortium project that was introduced in 2017 in Zimbabwe targeted farmers in the Matobo district where rains are erratic and the production of other cereals such as maize, soybeans, and wheat has always been very low. Quinoa pilot farming projects primarily promote the improvement of food banks for households in the area as well as becoming a source of income. Research has shown that a kilogram of quinoa on the international market costs US$5 while maize costs US$0.30 thus giving quinoa more priority in dry regions.

Studies concluded that quinoa production and promotion trends in Pakistan were concluded to be a superfood due to its extraordinary nutritional components that are far greater than those found in conventional cereals [18]. The study revealed the significant capability of quinoa to withstand the challenges of climate change and salinization. Quinoa can manage the hardest climatic conditions, as was witnessed in Pakistan when the crop was introduced. Literature shows that quinoa has not been fully explored in countries that are not in Asia or South America, making it more suitable to address the shortage of cereals and the high cost of stock feeds that have hit most countries since the inception of the COVID-19 pandemic. Quinoa was introduced to the African continent in the late 90s when Kenya started growing, followed by Malawi, which intensified its growth in 2012 [20]. Other countries that are now growing quinoa in Sub-Saharan Africa include; Zimbabwe, Malawi, Ethiopia, Zambia, Lesotho, and Mozambique. Quinoa has grown well in a variety of agroecological zones ranging from warmer to cooler.

4.4 Challenges that can Impede the Use of Quinoa Seed as an Alternative Ingredient in Stock Feed Manufacturing

Based on the several prospects of adopting quinoa seed as an alternative ingredient in the manufacturing of stock feeds, its global expansion is associated with several factors. [19] explored the challenges that impede the global expansion of quinoa adoption for livestock feed production. [19] described quinoa as an alternative crop for addressing food insecurity across the world. The major suppliers of the seed since the past decade are Peru and Bolivia, of which produced in the Andes has also shown a huge increase, while the production of quinoa has been hard hit by challenges that reduced yields and prices of the quinoa seed on the market.

One of the challenges that have been reported to be impeding the production of quinoa is the existence of Chenopodiaceae weeds, pests, and diseases that have not been fully addressed [19]. The problem of pests and diseases has lowered crop yields in the past few years, particularly in Peru and Bolivia. Quinoa is mainly affected by Andean pests such as Eurysacca melanocampta (Meyrick) which are mainly dominant in Peru and Bolivia. The African countries that are growing the plant, such as Kenya and Malawi, are also facing the same challenge, and this presents a huge challenge for farmers who would want to venture into quinoa-growing projects. A study surveyed the insect pests that attack quinoa in Zimbabwe and the study was carried out at Midlands State University and revealed that the major natural enemies of quinoa include; aphids, brown stick bugs, grasshoppers, and bollworms (lepidopteron) [12]. The study implied that there is a need for an improvement in the fighting of insect pests in Zimbabwe to prevent yield losses.

Further, [12] state that the major natural enemies of the quinoa plant in Zimbabwe are black ants, ladybirds, beetles, and hymenopteran wasps. Since this first study is so far the first to have reported pest insects that affect quinoa, farmers

need to establish the best control mechanisms that can help prevent damage to the growth. In the same vein, cultural practices and biological pest control practices can be adopted to ensure that crops are not destroyed. However, researchers have suggested the use of modern technologies in establishing creative ways to overcome the challenges that are faced in the production of quinoa.

The world has largely experienced drastic climate changes that have affected agricultural production with traditional crops such as maize and wheat being the most affected. As reported by the media (Standard) Quinoa gives hope for Zimbabwe's most dry regions based on the fact that these regions have been struggling to provide adequate stocks of food for most households based to continuous induced droughts [12]. Farmers can escape the vicious cycle of drought by growing drought-resistant quinoa varieties. Thus, the declining maize yields in Zimbabwe can be supplemented by quinoa which appears to be a panacea for food security. This is evidenced by the pilot project by Sizimile Consortium in collaboration with the Organisation of Rural Associations for Progress (Orap) in which the Midlands State University (MSU) tested the project which was a success.

The cultivation of quinoa has a long history, particularly in the USA's most populous states. The commercial networks for production around the world have expanded, though they have been affected by some challenges. Lack of access to high-yielding varieties is the biggest challenge for the growing of quinoa, particularly in the USA [4]. This implies that farmers who embark on quinoa farming projects should source quinoa varieties with better yields to maximize production. Additionally, another barrier to quinoa farming is low market prices in times when there is good production of the crop, particularly in South America. Fascinating is the fact that there are no registered pesticides for use on quinoa, making it a huge challenge for the effective control of weeds and pests. Thus, farmers, as compared to other cereals, can fail to reach the highest possible yields based on the unavailability of weed and pest control mechanisms.

Evidence in research shows that quinoa can negatively affect the gut which contains prebiotic effects. Research evidence lays out the various health benefits of quinoa to human and animal health which stimulate healthy digestion, helps in maintaining weight, help in the prevention and treatment of cancer, as well as acting as a gluten-free alternative. Another study posits that quinoa prevents the occurrence of bone diseases, and regulates the levels of glucose in the blood [11]. Quinoa can improve intestinal health though as found in vitro studies it has a prebiotic effect that promotes the growth of bacteria and the development of Short-chain fatty acids (SCFAs) [9,20].

5. Methodology

This paper assessed the impact of using quinoa seed as an alternative ingredient in the manufacturing of stock feeds in Zimbabwe. To fully explore phenomena and gain a better understanding of the contribution that quinoa can make to the stock feed manufacturing sector, the paper used a qualitative research approach. Desk Review and research were employed to analyze data that was generated from online reports, opinion pieces and blogs, research and report publications, peer-reviewed journal articles, and media reports, among other secondary sources of data. Desk research provides fast and credible background insights about a phenomenon being studied [21]. Also, desk research is cost-effective in the sense that the findings were generated using online sources without incurring any costs as compared to other research methods such as experimentation. On the contrary, desk research can be biased in some instances in which data availability might be a challenge. In this paper, the researcher ensured data maturation by exploring all the sources that were related to the study questions. The analysis of the available data sources was done thematically, from which the researcher was able to draw conclusions and make recommendations for the study. The study questions guided the review, in which the paper presented and discussed answers to the research questions. The study findings were compared and described in terms of their contribution to the understanding of quinoa in the findings report, which was thematically organized.

6. Findings

The findings that were generated from the desk review were presented and analyzed in line with the key questions of the paper. The findings informed the fundamental contribution of quinoa seed as an alternative ingredient in the manufacturing of stock feeds in Zimbabwe.

6.1 Impact of Quinoa Seed as an Alternative Ingredient in Stock Feeds Manufacturing in Zimbabwe

Several sources of data on the web were reviewed on the impact of quinoa as an alternative ingredient in the manufacturing of stock feeds. When quinoa seed was compared to conventional cereals, it was discovered that it primarily contains high-value nutrients such as proteins, unsaturated fatty acids, and fiber, among others, making it more suitable for the production of stock feeds. Major studies that were reviewed, [16,11,17,18] revealed that quinoa can be used as a low-cost and highly nutritive ingredient in the manufacturing of stock feeds. Based on the high prices of stock feeds in Zimbabwe and the scarcity of cereals such as maize, wheat, and soybean, stock feeds manufacturers in the country have been incurring higher costs to produce feeds, so they have ended up exporting some of the raw materials. The local production of quinoa in Zimbabwe can enable the local manufacturers to use it as an alternative ingredient and produce feeds that are highly nutritive and at low prices that maximize profits for animal farmers. Stock feed producers in Zimbabwe, for example, can improve the competitiveness of their brands when compared to stock feed brands made from conventional cereals.

Quinoa was found to be highly effective in replacing convectional cereals due to its ability to withstand a variety of climatic conditions, whether hot or cold. The majority of blogs, reports, and publications pointed out that quinoa is regarded as the world's healthiest plant that maximizes animal health [4]. It was pointed out that stock feeds from quinoa highly improve the quality of meat as compared to other ingredients, as was realized in Japan [5]. Additionally, the Zimbabwean community and Africa at large can significantly improve the quality of livestock products such as meat, milk, and skins, among others, by using feed mixed with quinoa seeds and leaves. This can be a great advantage to the country since the demand for its exports can increase based on the quality of livestock products it can produce using quinoa as an ingredient.

Scholarly evidence was established that Zimbabwe started pilot projects of quinoa farmers for farmers in Matobo in Matebeleland in which Sizimile Consortium project was facilitating the projects. The rewarding nature of quinoa is also interesting when it comes to the adoption of the plant in line with boosting the production of stock feeds. Quinoa also has positive health benefits for animals such as improving intestines healthy, effective regulation of glucose levels in the blood, and good for digestion [7,9]. These positive advantages of quinoa in adopting it as an alternative ingredient in the manufacturing of stock feeds are exceptional and fundamental for Zimbabwe given the huge shortage of stock feeds the country is already experiencing.

6.2 Challenges that can Impede the Use of Quinoa Seed as an Alternative Ingredient in Stock Feed Manufacturing in Zimbabwe

The challenges that impede the use of quinoa as an alternative ingredient in the manufacturing of stock feeds in Zimbabwe were informed by the information that was generated from various articles, blogs, and reports. The full adoption of quinoa in Zimbabwe was found to be hindered by specific factors that included the unavailability of the best quinoa seed variety for Zimbabwe, as revealed in a study on a quinoa farming project with the Women's University of Africa in which they assessed the effect of soil fertility amendment on quinoa varieties in Zimbabwe [10,12]. Given the increased availability of quinoa seeds in Zimbabwe, stock feed companies can maximize their profits and improve their brands because their stock feeds will become more preferable on the market based on the range of their advantages, such as improving the quality of livestock products in terms of proteins and fats in milk and meat.

One of the challenges that stock feed companies can face if they want to grow quinoa for their business is the unavailability of registered pesticides and weed control mechanisms for the crop. [4,2,17] the absence of weed and pest control can significantly reduce quinoa yield levels, which can also be compared to the same challenge faced by conventional cereal crops such as maize and wheat. This barrier poses a challenge for the country's agronomists and agricultural scientists to develop pesticides and other weed control mechanisms to promote the growth of quinoa locally. This will in turn result in the improvement of the quality of livestock products that are produced locally as well as an increase in exports of livestock products and even stock feeds that are manufactured with quinoa as part of the ingredients.

Another challenge that was found in the review is a lack of confidence and expertise about the growth of quinoa in Zimbabwe. Additionally, the majority of quinoa farmers are in South America, Bolivia, and Peru, while Kenya and Malawi in Africa have so far intensified the growing of quinoa seeds [19]. Thus, the findings imply that stock feed producers should gain expertise from the neighboring Malawi quinoa farmers to ensure that they have high yields and quality quinoa seeds that can close that gap in terms of the shortage of stock feed ingredients.

7. Conclusion

Quinoa is the healthiest alternative ingredient that can be locally used in Zimbabwe in the manufacturing of stock feeds. The use of quinoa improves the quality of animal health and livestock products such as meat, milk, fats and oils, and skins. Quinoa as an alternative ingredient reduces the cost of producing stock feeds in Zimbabwe as compared to conventional cereals such as maize and soybean. Quinoa seed use in stock feed manufacturing reduces the scarcity of stock feeds across the country.

8. Recommendations

To improve the quality of their stock feeds, Zimbabwean stock feed companies should invest in growing quinoa seed plants. This will improve the competitiveness of their brands in the stock feed business. The government, together with the Ministry of Agriculture, should seriously consider using quinoa as an engine for improved agricultural production in Zimbabwe, especially livestock production. When compared to conventional cereals, this has the potential to transform the country's economy and increase its Gross Domestic Product (GDP) by a greater margin. Stock feed companies should develop training programs in which they engage stakeholders who have experts who can train farmers on how to grow quinoa, taking advantage of its robustness in withstanding both high and low temperatures as well as changing climatic conditions. Policymakers should advocate for funding for the agriculture sector and stock feed companies to begin intensifying quinoa-growing pilot projects in Zimbabwe to address the severe shortage of conventional cereals. This will improve the availability of stock feeds and reduce their prices, as well as improve the quality of livestock products available in the Zimbabwean market.

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