STRATEGIC ACTION PLAN FOR SUSTAINABLE BUSH VALUE CHAINS IN NAMIBIA
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Acknowledgment and gratitude are expressed to the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) for the extensive work, including the programmes and projects being implemented in the areas of natural resources and economic development, in particular, bush control and value addition opportunities for bush encroachment in Namibia. The results of this work, such as valuable data and studies, were extensively referred to and used as the basis for development of this report.
Foreword

In 2014, Namibia launched a “Growth at Home” initiative that is committed to deliver inclusive and sustainable industrial development (ISID), to stimulate economic growth, promote trade and direct investment. This is in response to national priorities, viz-a-viz, reducing the annual trade deficit1 through investments in manufacturing for import substitution, value addition of raw materials (minerals and other natural resources) and product development for export markets. The initiative is the implementation framework of the National Industrial Policy of 2012. It is foreseen that the Growth at Home Strategy would enable sustainable employment creation, skills development for a self-reliant and industrialized economy and increase economic participation by previously disadvantaged Namibians. To this end, Namibia also launched the Micro, Small and Medium Enterprise (MSME) National Policy: 2016-2021 in November 2016.

The United Nations Industrial Development Organization (UNIDO) technical cooperation project “Promoting sustainable bush-processing value chains in Namibia” is in line with the Ministry's Growth at Home Strategy, and the Government and people of Namibia are grateful to the Government and people of Finland, UNIDO, and local private sector partners for their support. This project resonates with pertinent national development goals and would contribute toward Namibia’s achievement of the Sustainable Development Goals.

The Ministry is aware that bush encroachment is a regional challenge and ensured that UNIDO presented the project and its potential benefits during the “2018 SADC Industrialization Week”. Namibia is leading the way in the region to define and mobilize environmentally, socially and economically viable bush value chains (BVC). Given the extent of encroachment across Southern African Development Community (SADC), and the occurrence of viable species and bush densities, it was proposed that SADC consider BVC as one of the priority regional value chains. At national level, BVC could enable countries to generate sustainable employment, develop capacities for an emerging agribusiness sector, recover rangelands, enabling higher rates of groundwater recharge, and improve local food security and availability of affordable animal feed.

Currently more than 90% of soybeans and more than 50% of maize and wheat are diverted for animal feed production annually. The UN Food and Agriculture Organization of the United Nations (FAO) estimated in 2017 that $21 million people across the world are undernourished daily with Africans making up more than a third of this. SADC’s 2018 Regional Vulnerability Assessment and Analysis estimated that 14% of the region’s population are undernourished, and suggests climate change impacts as the key driver of increasing food insecurity and reducing food production.

The Ministry is convinced that, once the pilot phase of this project proves commercial viability, it is worth scaling up nationally and replicating across SADC to improve our climate change resilience and adaptive capacities. We believe that this project can assist our country and region to advance toward low-carbon, high resilience and inclusive economies.

HON. TJEKERO TWEYA
Minister of Industrialization, Trade and SME
Development of the Republic of Namibia

1 Trade deficit between US$ 1.4 to 1.7 billion/year. Source: Namibia Statistics Agency

Finland and Namibia have developed an exceptionally long and close relationship that dates back more than 150 years. Namibia became one of Finland’s most important development partners, immediately after its independence in 1990. In Namibia, Finland is valued as a committed and reliable partner. Both countries are exploring new ways to strengthen cooperation with specific emphasis on trade and industrialization. While Namibia is endowed with natural resources and good market access to the region and world at large, Finland’s competitive advantage is based on technology, innovation and knowledge that have been built by its world-class education system of high equality and opportunities for all.

Over the last decades, Finland has carried out versatile studies related to feed production, processing and use, including novel feeds and efficient use of by-product flows for all farm animals. Now, we are turning the fruit of these studies into reality, together with the United Nations Industrial Development Organization (UNIDO), Government of Namibia, Baoabab Capital Ltd and a number of Finnish private sector and academic partners, in the form of a full-fledged business–technology model that helps Namibia develop sustainable production and value chains using the Acacia bush for a wide variety of products.

This technical cooperation project “Promoting sustainable bush-processing value chains in Namibia” contributes to both the national sustainable development objectives of Namibia and the United Nations Sustainable Development Goals. More concretely, bush-based feed has proven to be not only a drought relief feed, but also a more affordable production ration. By funding this initiative, the Government of Finland acknowledges the great potential of utilization of invasive bush species in the animal feed, food and pharmaceutical industries, as well as in energy production sectors, to generate jobs, food and income in Namibia.

Finland stands ready to continue supporting the current efforts towards environmental and climate sustainability in a drought-stricken Namibia by using encroaching bush to produce animal feed, energy, chemicals and other value-adding products. The Government of Finland and our national academia, R&D and private sector partners look forward to the successful functioning of the pilot plant and the opportunities it will offer to the wider communities, including women and marginalized people, as well as for business. We truly believe that by joining hands we will be able to leverage new and innovative potential for employment generation, environmental restoration, climate sustainability and economic development.

DR. MIKA VEHNÄMÄKI
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Ministry for Foreign Affairs of Finland
# Table of Contents

## ACKNOWLEDGMENTS

5

## FOREWORD

6

## EXECUTIVE SUMMARY

11

### 1. INTRODUCTION AND BACKGROUND

19

### 2. ENCROACHER BUSH: Viable, Sustainable and Suitable

25

#### 2.1 Bush Species Distribution and Densities

26

#### 2.2 Bush Biomass - Suitability for Feed

28

### 3. TARGETED BUSH-PROCESSING VALUE CHAINS

31

#### 3.1 INTEGRATED ZERO-WASTE FEED-CHARCOAL PRODUCTION

32

#### 3.2 ASSESSMENT OF THE TARGETED VALUE CHAINS

36

#### 3.3 FURTHER BUSH VALUE CHAINS TO BE EXPLORED

37

### 4. INTERNATIONAL DEVELOPMENT EFFORTS: SYNERGIES AND COHERENCE

41

#### 4.1 DEUTSCHE GESELLSCHAFT FÜR INTERNATIONALE ZUSAMMENARBEIT (GIZ)

42

#### 4.2 UNITED NATIONS DEVELOPMENT PROGRAMME/MAWF PROJECT

43

#### 4.3 UNIVERSITY OF NAMIBIA (UNAM)

43

#### 4.4 SEINÄJOKI UNIVERSITY OF APPLIED SCIENCES

43

### 5. PRODUCTION SYSTEM, TECHNOLOGY APPROPRIATENESS AND SUSTAINABILITY

45

#### 5.1 CURRENT STATUS AND TRENDS OF BUSH FEED PRODUCTION

46

##### 5.1.1 Bush control and harvesting methods

46

##### 5.1.2 Bush chipping

48

##### 5.1.3 Drying

50

##### 5.1.4 Mixing

51

##### 5.1.5 Milling/Blending

51

##### 5.1.6 Pelletizing

51

##### 5.1.7 Recipes and end-products

52

##### 5.1.8 Summary of current practices and trends

53

#### 5.2 CURRENT STATUS AND TRENDS OF CHARCOAL PRODUCTION

53

##### 5.2.1 Charcoal: origin, uses and characteristics

53

##### 5.2.2 Namibia Charcoal Association (NCA)

54

##### 5.2.3 Jumbo charcoal

54

##### 5.2.4 Makari charcoal products

55

##### 5.2.5 Traditional drum kiln versus retort system

55

##### 5.2.6 Charcoal production in Namibia

56

##### 5.2.7 Current and potential capacities as incentive for improvement

56

##### 5.2.8 Structure of charcoal business in Namibia

57

##### 5.2.9 Investigations and opportunities

57

### 6. INSTITUTIONAL AND LEGISLATIVE OVERVIEW

63

### 7. IMPACTS AND RISKS

67

#### 7.1 KEY ENVIRONMENTAL CONSIDERATIONS OF BUSH ENCROACHMENT

68

#### 7.2 ENVIRONMENTAL ISSUES CONCERNING ANIMAL FEED

69

#### 7.3 ENVIRONMENTAL ISSUES CONCERNING CHARCOAL

70

#### 7.4 KEY SOCIAL CONSEQUENCES OF BUSH ENCROACHMENT

71

#### 7.5 FOLLOW-UP MEASURES

71

##### 7.5.1 Follow-up measures methods

71

##### 7.5.2 What comes after follow-up measures?

71

##### 7.5.3 Rangeland Management Policy and Strategy

72

#### 7.6 RISK ANALYSIS AND MANAGEMENT

72

### 8. INVESTMENT CASE

75

#### 8.1 SUMMARY OF KEY METRICS

76

#### 8.2 FINANCIAL OVERVIEW AND HEADLINE PROJECTIONS

76

#### 8.3 MARKET OVERVIEW OF THE ANIMAL FEED PRODUCTION

77

##### 8.3.1 Global market overview

77

##### 8.3.2 Regional market overview

78

#### 8.4 COMPETITOR ANALYSIS AND ECONOMIC IMPACT

79

##### 8.4.1 Namib Mills Investment Group

79

##### 8.4.2 Other Bush-to-Feed production in Namibia

80

##### 8.4.3 Feed prices in Namibia

80

##### 8.4.4 Shifting Namibia’s trade balance

80

#### 8.5 GLOBAL AND REGIONAL MARKET OVERVIEW: CHARCOAL

81

##### 8.5.1 Top charcoal exporting and importing countries

81

##### 8.5.2 Charcoal production in Namibia

81

##### 8.5.3 Current and potential capacities as incentive for improvement

81

##### 8.5.4 Structure of charcoal business in Namibia

82

##### 8.5.5 Current drum kiln operations as reason for suggested improvement

82

##### 8.5.6 Investigations and opportunities

83

### 9. CONCLUSION: UNIDO PROJECT IMPLEMENTATION AND OUTLOOK

85
Executive Summary
More than 60% of the population engages in agriculture on 78% of the total land surface. A domestic cereal deficit of 76% was reported for the previous two years, due to lower farming productivity, while in 2017, 300,000 cattle weaners at a value of N$1.6 billion were exported due to limited capacity to retain and raise. This limitation affects 200,000 households, including the macro-economic impact of the sector. Jointly with Namibian and Finnish partners, the United Nations Industrial Development Organization (UNIDO) through its technical cooperation project “Promoting sustainable bush-processing value chains in Namibia” is addressing this limitation, drawing extensively on existing information and data generated by the Government and development partners, by conducting in-depth analysis and investigation of the viability of inclusive and sustainable bush value chains for economic benefit and to contribute to rangeland restoration.

Covering an estimated surface of 45 million hectares, a harvest rate of 10 tonnes/ha would translate into a theoretical total biomass of 450 million tonnes. The actual availability of this biomass depends entirely on the species selected, suitable value chains, and end-use products, as well as the cost of harvesting, processing, and value addition/product development versus the potential benefits. Considerations of scale (individual vs. industrial), and the level of investment, and adoption of technology become important, in parallel with the risks inherent with developing a new product for which no, or at best, a semi-developed local market exists. The scale would determine whether a “multiplier effect” can be triggered for enhanced social, environmental, and economic benefits.

INTERNATIONAL DEVELOPMENT EFFORTS: SYNERGIES AND COHERENCE

Over the past five years, the Government of Namibia, with support from development partners, increased efforts commensurably to address bush encroachment. The Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) is implementing two synergistic projects on “Competitiveness for Economic Growth” and “Bush Control and Biomass Utilisation”; the former, in partnership with the Ministry of Industrialisation, Trade, and SME Development (MITSMED), is developing the capacities of government and industry to identify, investigate, and develop value chains, the latter, in partnership with the Ministry of Agriculture, Water, and Forestry (MAWF), is a second-phase project transitioning from a research and development intensive phase (2014-2017) toward practically improving bush control and biomass utilisation.

The University of Namibia (UNAM) plays an important role as a research and development partner and recently showed interest in the project from the perspective of innovation for sustainable development since it now has a legal business entity that can engage in public-private partnerships. The nutritional and mineral properties of five species of encroacher bush were analysed as part of the demand also exists for an additional 100,000 tonnes of charcoal per year. However, this potential is also contingent on the competition in the domestic market from feed/supplement/additive manufacturers and importers with relatively long histories in Namibia. Furthermore, for variations in bush-based feed recipes, the accessibility and sustainability of supply and cost of raw materials (e.g., molasses) are critical risk factors.

In 2017, 300,000 cattle weaners at a value of N$1.6 billion were exported.
ENVIRONMENTAL IMPACT REVIEW

An article published in late 2017 in the peer-reviewed Environmental Journal ofNamibia provides valuable guidance regarding possible environmental impacts of bush harvesting and thinning. Even though bush encroachment presents an environmental threat, the article describes the positive role that encroacher bush plays in the ecological and ecosystem functions by providing shelter/habitat for birds, insects, and other animals that act as natural fertilizers and soil mineralisers.

Hence, in addition to the direct impact of harvesting (i.e., soil disturbance) to produce both charcoal and livestock feed, there is a need to consider the wider ecological impacts of bush removal, while the production of end-use products may have further direct and indirect environmental and social impacts, both positive and negative.

Namibia has a sound institutional and policy framework to support the consideration, quantification, and assessment of impacts. Operators in the emerging bush value chains market sector must consult with the Ministry of Environment and Tourism (MET) and adhere to the Environmental Management Act (EMA) and its regulations. The EMA requires the consideration of sector-specific legislation, including labour laws and regulations, particularly in view of human health and safety as well as work conditions.

Environmental and social impact considerations apply to the sites where end-use products will be manufactured, as well as to the distribution and density favours manual labour for harvesting over some mechanised approaches, particularly with respect to accurate selection. Hence, adding value by focusing on the supply of wood biomass would definitely provide opportunity for employment, while activities closer to the actual production of end-use products would provide less potential for employment.

Time to market is an important parameter to consider, since it depends on whether well-developed markets already exist and how fast a product can be brought to market. For livestock feed, a semi-developed market exists at best, since many farmers blend bush material with supplements/additives during droughts and there is a well-established commercial operation in the Otavi area. Building on this foundation, more awareness is needed, especially of observed product benefits (daily/weekly average weight gains) and of the role that de-bushing can play in rangelands restoration.

The potential multiplier effect of social, environmental, and economic benefits is possible, granted high demand for a new product such as animal feed that has been widely tested in the Namibian market, is priced competitively, and offers well-assessed benefits. Again, the scale and scope of an operation would also determine the extent of benefits and the potential increase in the number of beneficiaries. At the production level, the extent would be increased by an integrated process as described above while raising the yield from wood-to-charcoal (by up to 40%).

MARKET POTENTIAL OF ANIMAL FEED

Key considerations for the market potential of a bush-based animal feed include:
- compelling and balanced nutritional values (based on recipes);
- shelf-life comparable to that of similar products on the market;
- consistent quality through assurance and control;
- palatability and digestibility; and
- competitive and appropriate pricing.

With regard to nutritional values, the balance of ingredients to enhance or mitigate some properties of bush material is important in gauging market potential. Fibre content should be optimal for digestion, while prevailing opinions suggest that tannins can have positive or negative impacts on the digestibility of bush material and the absorption of nutrients. Acacia bush material delivers up to 16% protein, which is higher content than that of many existing feeds, and when that bush material comprises more than 85% of the feed, it leads to daily weight gains of between 0.6 to 2 kg, with an average of 1.2 kg/day. In a case where bush biomass comprised 58% of the feed and was fed daily at 3% of the weight of the cow, a weight gain of 427 kg was recorded over a 50-day period. The Meat Board of Namibia reported that daily weight gains of 1.2 to 1.8 kg are possible under irrigated grazing conditions by using an enhanced fodder.

A “growing” bush-based feed trial conducted by the GIZ Support to De-bushing Programme recorded daily weight gain of up to 3 kg. GIZ sampled different bush species for the attractiveness to livestock, based on their nutritional values and palatability. The international average daily weight gain ranged between 500-700 g.

More data are needed on species nutritional values and variations therein according to geographic variations, followed by feeding trials over wider geographic areas with variable conditions to validate these initial results, in order to allow the delivery of market-relevant and attractive recipes. The current data serve as a proxy that suggests definite market potential, particularly based on the weight gains recorded, at a competitive price.

Shelf-life is an important indicator to access and unlock market potential. Current recipes provide between 6 to 12 months’ shelf-life. It is important for the bush material to be dried completely after chipping to produce a dry biomass powder from the hammermill. Additives and product storage conditions are vital to safeguard shelf-life, which is an important indicator for business viability, from sustainable production, consumption, and loss/”product write-off” points of view.

A strong and acknowledged possible supplier is FeedMaster, which delivers an impressive annual output of 160,000 tonnes worth N$800 million, implying an average price per tonne of N$5,000. It caters to the entire ruminant market with 31 products for cattle alone, mainly supplements, concentrates, and additives. This company has existed in Namibia for 32 years and emerged from the biggest milling
MARKET POTENTIAL OF CHARCOAL

The Namibian charcoal value chain comprises harvesters and small-to-large-scale producers (including Makarra Bush Products) and processors (e.g., Jumbo Charcoal) that supply the domestic, regional, and international markets. With 6,000 to 10,000 participants in the industry, regulation is limited or non-existent, as indicated by the negative prevailing human and environmental health and safety issues. Jumbo Charcoal has been operating since 1983 and does not produce charcoal but rather procures unprocessed bulk charcoal by the tonne from producers. It absorbs the cost of processing, branding, and marketing to deliver final packaged market-specific products that are sold at a premium. A product of note is a “ready-to-burn” 2 or 5 kg bag of paraffin-treated charcoal sold on the UK market, which absorbs 22% of charcoal exports from Namibia. Given the weather in the UK, this product is ideal as it ignites with ease and allows a grill to be barbeque-ready in less than 20 minutes.

The Namibian Charcoal Association (NCA), with support from industry players, the MAWF, and GIZ, is in the process of reforming the industry and improving its coordination. This effort is applauded, and it must be recognised that with as many as 10,000 stakeholders, this requires time, resources, and support to achieve. The Namibia Biomass Industry Group, supported by the GIZ, provides access to information to raise awareness and capacity and to coordinate and facilitate the use of bush biomass, particularly linking farmers with harvesters/processors, as in the case of Ohorongo Cement.

Some 26 million ha of farmland are affected by bush encroachment, a development that has encouraged farmers to solicit small-scale charcoal producers to thin bush and produce charcoal. This informal engagement has its benefits but also comes with challenges pertaining to indiscriminate species selection, limited care and concern for human and environmental health, variable quality (size and density) of charcoal, delivering only 30-40% charcoal from total wood used. Kilns are relatively inexpensive (N$5,000 apiece) and easy to make, using flat 3-5 mm metal sheets in standard dimensions as sold to limit the cost of production. The sheets are rolled into a cylindrical shape.

There is potential for an additional 100,000 tonnes of charcoal per year, given the regional and global demand. This goal can be achieved with a relatively modest investment in a modern containerised charcoal retort that can achieve 40% higher yield than the current Namibian system without any significant human or environmental health impact concerns.

CONCLUSIONS AND IMPLEMENTATION PROGRAM

An integrated approach to charcoal and livestock feed production to optimise investment, production processes, and outputs/end-use products is proposed as an attractive viable approach to address market potential. This would be complemented by marketable by-products from charcoal production at no additional marginal cost of production.

Based on information and data from Finnish technological companies, the estimated investment cost for such a system would be in the region of N$10 million. This would comprise one modular and containerised bush-to-feed system that can deliver 2.5 tonnes per day, two containerised retort systems for charcoal production that deliver tar and distillates, and the equipment for selective harvesting, all presenting minimal negative social and environmental impacts. A time window of six months from date of order is required to deliver the technologies in Namibia, while the companies would provide on-site presence for installation, testing, commissioning, and capacity development.

To enable the demonstration of the above-mentioned proposed system, a practical strategic action plan is proposed with specific milestones, costs, and a completion timeframe.

Integrated approach for charcoal and livestock feed production
Investment, production and output optimization
Technology adaptability: machines, equipment and systems

Estimated investment cost of EUR 795,000-930,000
Time window of 6 months for technology delivery
Introduction and Background
Namibia is one of the most vulnerable countries in the world to the impacts of climate variability and change. The country's inherent vulnerability, due to its geographic position on the globe and subcontinent, is further exacerbated by an inherent water deficit and exposure to high temperatures during the summer/spring months (Sep-Feb). Evidence of climate variability and change includes a short, variable, and intense rainy season resulting in lower water availability and increased temperatures that have been above the global mean for the past 10 years. Farming ability has been reduced by up to 75% in some areas, while it is becoming increasingly challenging for the rural population to sustain livelihoods and income from accessible arable land that makes up less than 2% of the country’s territory. Water is a high-value commodity in Namibia as only 1% of rainfall recharges underground aquifers, with the rest lost to evaporation and runoff. More than 60% of the population is engaged in some form of agriculture that supplies up to 40% of the country’s food demand. As a sector, agriculture employs the highest number of people in the country and is the second highest contributor to GDP.

The above baseline is exacerbated by bush encroachment, which is the occurrence of high densities of woody species—particularly Acacia species and “Sickle bush”—that grow at the expense of endemic grasses and forage plants, thereby reducing the grazing potential and roaming space for livestock and wild animals and the endemic grasses and forage plants, thereby reducing the grazing capacity for crop cultivation.

At present, up to 45 million hectares in 13 of the 14 political regions are experiencing bush encroachment at an annual growth rate of 3.18%, resulting in some 1.5 million hectares of additional bush each year. This encroachment translates into the following impacts:

- Reduction in rangelands and grazing areas;
- Poor groundwater replenishment and excessive water consumption by encroacher bush (up to 65 litres per day);
- Reduced food production capacity resulting in lower food security and higher malnutrition, especially when rural households need to increase expenditures to buy food;
- Lower employment in the agriculture and tourism sectors (including up- and downstream activities);
- Changes in local biodiversity leading to the disappearance of some species and appearance of others, as well as to species, community, and habitat fragmentation;
- Reduced potential for animal wildlife viewing due to dense vegetation that reduces visibility and restricts animal movement.

This negative impact is being recognised in the tourism sector as it reduces the ability to sell “access” to animal wildlife and Namibia’s popular “wide open spaces”;

- Annual exportation of 200,000-300,000 cattle weaners at N$1.5 to 1.8 billion. If they were retained and raised to market size, Namibia could fetch an additional 40%, i.e., capture a total net economic value of more than N$3.2 billion per year, not to mention the employment opportunities for viable meat value chains from feedlots and abattoirs through processing and value addition as final products.

Bush encroachment is still recognised as a formidable sustainable development challenge, but, in recent years, stakeholders have become more curious about socially, economically, and environmentally viable opportunities. Hence, extensive bush control and utilisation of bush biomass could catalyse enhanced agricultural productivity, which would, in turn, strengthen the overall resilience of farmers and rural communities. The MAWF/GIZ-funded “Support to De-bushing Programme” proposed 14 viable bush-based value chains in 2015 with constructive guidance on requirements (investment, skills, technology) for ways to develop one or more value chains.

To harness the opportunities and address the challenges of bush encroachment, the Ministry of Industrialisation, Trade and SME Development (MITSMED) and the United Nations Industrial Development Organization (UNIDO) partnered in August 2017 on a project, “Promoting sustainable bush-processing value chains in Namibia.” The project is jointly funded by the Ministry of Foreign Affairs of Finland and Baobab Growth Fund (Pty) Ltd, a local private sector partner. Unlike previous and other existing projects that focus on assessments and scientific studies, this project aims to test and put into operation a sustainable and viable business model able to deliver marketable end-use products, generate employment, and contribute to economic growth and industrial development. The project is being implemented in two phases: phase 1 (Aug 2017 – Mar 2018) delivered a viability analysis—this Strategic Action Programme—which recommends investing in a demonstration plant to test actual viability, the technology, and to enable fine tuning and refining the products and business model; phase 2 (Apr 2018 – Nov 2020) entails the planning, facility start-up, and testing of the demonstration plant.

The direct outcomes of this project would include (by 2020):

1. Marketable, viable, and sustainable bush-based value chains and end-use products developed using best available market and business intelligence information and data;
2. Suitable, appropriate, and affordable technologies (imported, locally modified/adapted and manufactured) and know-how that enable sustainable harvesting in compliance with national laws and the Forestry Stewardship Council (FSC); and
3. Namibian business (individuals, institutions, and systems) that can locally develop and maintain technologies, identify suitable technology and apply it appropriately throughout bush-based value chains; and train others in bush-based value chains to ensure high quality service delivery, product development, and use of technology.

Even though recognized as a challenge, encroacher bush plays important ecological roles in nature. Hence, there is a focus on extensive bush control instead of mass clearing of bush to address the challenge. The project has therefore become aware of the harvesting methods in use and their associated impacts6 and would endeavour to employ the optimal solution to meet the bush biomass demands of the demonstration plant. Of the 14 value chains that are presented as viable for Namibia, this project focuses on bush-based animal feed and charcoal. For both, there exist well-developed and tested markets in Namibia. Potential may be unlocked regionally and globally by showcasing Namibian data as a means of arousing curiosity in farmers who could participate in feeding trials. At present, the bulk of nutrition in all mainstream feeds comes from soybeans, wheat, and maize. The demand for animal feed is increasing—in parallel with the human population growth trend—worldwide production having reached 1 billion tonnes in 2016 and 2017 for the first time ever. The demand for food for human consumption is increasing in developing countries and emerging markets. As the middle class is growing in Africa, Asia, and South America, so is the demand for protein, while for the poorer households, maize, wheat, and soybeans are important nutritional components.

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Arguably, animal feed is an important factor in the global food industry, enabling the economically viable production of animal proteins throughout the world. Feed, as demonstrated in modern sustainable agriculture, is the largest and most important component for ensuring safe and affordable production of animal proteins. The main factors determining the composition of animal feed and their retail price are the prices of the raw materials, the nutritional value of the components, and the nutritional requirements of the specific animals, as well as the national legislative and regulatory environments.

The world’s human population has been experiencing accelerated growth that will soon be exponential. Accelerating population growth is a major concern, particularly for policymakers, as it pertains to our ability to feed and provide fuel for the current 7.2 billion-plus people in our world.

In Namibia and South Africa, farmers are known to have experimented with bush-based feeds as early as 1970 – as a measure to survive years of drought. Two farm owners have gone into commercial and semi-commercial/experimental production. "BioPro Products" emanating from the Otjozondjupa region is the first registered commercial bush-based animal feed containing 58% bush biomass, while the other farmer in the Dordabis area experimented with a bush-based feed comprising up to 85% bush biomass, producing maximum weight gains of up to 2.5 kg per day per animal. Over the past five years, MAWF-supported projects developed bush-based experimental feeds and carried out feeding trials that enabled the recording of data on the nutritional and mineral values of bush species and the uptake ability and growth gains by livestock. Cattle, goats, and sheep were trial fed on 5 different feeds of bush-based feeds in the Omahke and Kavango West regions. There is need for more trials across wider geographic areas covering livestock, animal wildlife, and other species such as horses.

A well-developed market for charcoal is jointly overseen by the MAWF and the Namibia Charcoal Association (NCA) and is characterised by an unmet annual demand of 100,000 tonnes, with between 6,000-10,000 producers, processors, marketers, and exporters engaged in the sector. Production efficiencies are low, at 30-40%, with enormous amounts of waste generated, adding to the many negative environmental and human health impacts currently observed in the sector.

In 2017, the NCA started a process of cleaning up the sector by offering more efficient, cleaner, yet rudimentary and affordable technologies, by verifying all persons in the sector and value chains, and by setting baseline health records.

To complement these efforts, this project will focus on an industrial-scale cleaner, 70% more efficient technology that would be integrated with the bush-based feed mill for an even more efficient and zero waste/circular economy approach. The retort containerised system is thus designed to deliver (for example) 70 kg of charcoal for every 100 kg of wood processed, without any CO2 emissions and with distillates and tar by-products at no additional cost. Heat generated by the retort technology would be channelled to dry bush material in preparation for feed production. One hundred percent (100%) bush will be utilised; the leaves and twigs smaller than 20 mm in diameter are suitable for animal feed – comprising some 20% of total biomass per bush; while twigs and branches larger than 20 mm are suitable for charcoal (comprising some 80% of total biomass per bush).

The nutritional values in plants and bushes are higher during the rainy season; hence this period of the year (Sep-Apr) would be targeted for feed production, while charcoal production would be staggered over a 10-month period (Jan-Oct).

As alluded to above, a key focus of this project is to determine the sustainability and viability of manufacturing bush-based end-use products. Hence, the business model should suggest profitability through a reliable and market-based internal rate of return (IRR). The project is investigating the availability of supplemental raw materials (e.g., molasses, lucerne, prickly pear) in Namibia, the region, and worldwide to ensure that supply is sustainable and affordable at 30- to 50-year timeframes.

The demonstration plant would thus serve the purpose of showcasing the viability and sustainability of bush-based business, as well as the business processes, technology, and final products. This would generate awareness and interest among entrepreneurs who might have the appetite and/or resources to invest. Toward the end of the 12-month demonstration phase, a sound, tested business model and plan will be in place and ready for consideration by investors.

Various factors influence viability, for instance developed markets and readiness for new products, existing demand for different/affordable feed varieties, "time to market" as a reflection of business efficiencies and effectiveness, cost of raw materials (especially transport) and scale/range of production (see below). In this case, viability also extends to achieving a "triple-win," i.e., restoring rangelands and improving groundwater replenishment, in addition to bush-based feed and charcoal production. Hence, it is important to consider the annual scale of production such that the magnitude of encroacher bush harvesting yields the desired positive impacts on rangelands and aquifers. Social benefits would include substantive employment generation and capacity development.

Along with viability is the need to consider the risks associated with bush-based business as an emerging industry and particularly with developing animal feed as a new end-use product. Viability increases and risks decrease when the desired species is found on flat sandy topography with bush densities at 5,000 bushes/ha or more and within close range (5-10 km) of an operation site. Hence, as these parameters change, they influence the viability and risk factors of the intended business and therefore require careful calibration in concert with data on the availability and cost of other raw materials for feed production.

A draft National Strategy for the Optimization of Rangeland Management and Encroacher Bush Utilization is in place and under consideration by the Cabinet for approval. Once approved, this joint Strategy by the Ministries of Agriculture, Water and Forestry (MAWF) and Industrialisation, Trade, and SME Development (MITSMEDE) will be the guiding instrument for the next five (5) years to address the challenges and unlock the opportunities of bush encroachment. The Strategy proposes the establishment of "BBH" as platforms to promote and facilitate participation and to serve as one-stop-shops for all issues concerning bush encroachment, its challenges, and opportunities in that area. The Namibia Biomass Industry Group (N-BiG) has been leading consultations to define the BBH concept for Namibia and to agree on key elements for establishing, operationalizing, and managing them sustainably. The site – a decommissioned Africa Portland Cement site 10 km north of Otjiwarongo – intended for the demonstration of this project’s integrated bush-based feed and charcoal production system is well-placed to serve as a demonstration of a BBH. Another site, with a focus on bush-to-energy, is earmarked near Otjo, close to the Ohorongo Cement plant.

Operationalization of the National Strategy, introduction of the Bush Biomass Hubs concept, and planning for the demonstration of the production system are timely, as the project would gear up to achieve specific objectives and outcomes of the National Strategy while adding immense value to the BBH concept through a learning-by-doing approach and, lastly, delivering Namibia’s first promising triple-win solution to bush encroachment.

BUSH BIOMASS AS FEED INPUT TO ENHANCE HUMAN FOOD SECURITY – Given the growing demand for food for the human population, competition between the food and animal feed industries for these inputs (maize, soybeans, and wheat) is increasing. This competition will intensify as the world’s population is projected to reach 9 -10 billion by 2050. Growth in human population drives an increasing trend in animal protein consumption (especially beef). Hence, the demand for animal feed is expected to maintain the steady increasing trend observed from 2012 to 2016. One solution is to find suitable, affordable, sustainable, and palatable substitutes for maize, wheat, and soybeans such that these can be comfortably available for human nutrition.

In Namibia and South Africa, farmers are known to have experimented with bush-based feeds – as early as 1970 – as a measure to survive years of drought. Two farm owners have gone into commercial and semi-commercial/experimental production. "BioPro Products" emanating from the Otjozondjupa region is the first registered commercial bush-based animal feed containing 58% bush biomass, while the other farmer in the Dordabis area experimented with a bush-based feed comprising up to 85% bush biomass, producing maximum weight gains of up to 2.5 kg per day per animal.

Over the past five years, MAWF-supported projects developed bush-based experimental feeds and carried out feeding trials that enabled the recording of data on the nutritional and mineral values of bush species and the uptake ability and growth gains by livestock. Cattle, goats, and sheep were trial fed on 5 different feeds of bush-based feeds in the Omahke and Kavango West regions. There is need for more trials across wider geographic areas covering livestock, animal wildlife, and other species such as horses.

A well-developed market for charcoal is jointly overseen by the MAWF and the Namibia Charcoal Association (NCA) and is characterised by an unmet annual demand of 100,000 tonnes, with between 6,000-10,000 producers, processors, marketers, and exporters engaged in the sector. Production efficiencies are low, at 30-40%, with enormous amounts of waste generated, adding to the many negative environmental and human health impacts currently observed in the sector.

In 2017, the NCA started a process of cleaning up the sector by offering more efficient, cleaner, yet rudimentary and affordable technologies, by verifying all persons in the sector and value chains, and by setting baseline health records.

To complement these efforts, this project will focus on an industrial-scale cleaner, 70% more efficient technology that would be integrated with the bush-based feed mill for an even more efficient and zero waste/circular economy approach. The retort containerised system is thus designed to deliver (for example) 70 kg of charcoal for every 100 kg of wood processed, without any CO2 emissions and with distillates and tar by-products at no additional cost. Heat generated by the retort technology would be channelled to dry bush material in preparation for feed production. One hundred percent (100%) bush will be utilised; the leaves and twigs smaller than 20 mm in diameter are suitable for animal feed – comprising some 20% of total biomass per bush; while twigs and branches larger than 20 mm are suitable for charcoal (comprising some 80% of total biomass per bush).
Encroacher Bush: Viable, Sustainable and Suitable

2.1 Bush species distribution and densities  26
2.2 Bush biomass - suitability for feed  28
Encroacher bush has historically been regarded as a challenge, and in recent years, more deliberately acknowledged as holding vast untapped potential social and economic benefits. A draft National Strategy for the Optimization of Rangeland Management and Encroacher Bush Utilization is a deliberate policy to unlock social and economic benefits. To harness the potential, it is important to gain as much knowledge and understanding as possible of the resource; the species and their distribution; nutritional, mineral, and other properties (e.g., calorific value), and the influence of soil composition and geology on nutritional and mineral properties.

**Viable and Sustainable** – The sheer volume of encroacher bush and the variety of species (see below) suggest viability and sustainability, depending on the value chain and end-use products. The Namibia Nature Foundation (NNF) estimated that a total net economic benefit of N$58 billion can be generated over a 25-year period. This estimation uses the following assumptions: 60% (11.8 million hectares) of 26 million hectares of bush encroached area can be targeted for bush thinning (i.e., suitable species for the intended end-use products). This activity could reduce bush densities by 67% over 25 years at an annual bush thinning rate of 5% (or 787,770 hectares) of the targeted area. The initial round of de-bushing (disregarding any follow-up measures) would be carried out over a period of 20 years, with the effects being captured over 25 years to allow for ecosystem services to reach their potential.

The information and data below are drawn from all available sources for an accurate depiction of the bush encroachment situation in Namibia. The figure below shows species that are recognized as the main encroacher species in Namibia. A targeted win scenario – particularly to positively impact rangeland restoration and thinning bush to open up landscapes for animal wildlife movement – the target must be encroacher bush species of densities between 2,000 to 10,000 bushes per ha, with tighter focus on those areas where densities are higher than 5,000 bushes per ha and matching the desired species for the most part (See map on next page – note species as A. mellifera).

**2.1 Bush Species Distribution and Densities**

The information and data below are drawn from all available sources for an accurate depiction of the bush encroachment situation in Namibia. The table and map in this chapter provide information about the main encroacher species, those that are of lesser importance as encroachers (i.e., negligible to limited impact) and species that are invasive. To pursue a triple-win scenario particularly to positively impact rangeland restoration and thinning bush to open up landscapes for animal wildlife movement the target must be encroacher bush species of densities between 2,000 to 10,000 bushes per ha, with tighter focus on those areas where densities are higher than 5,000 bushes per ha and matching the desired species for the most part (See map on next page – note species as A. mellifera).

![Species distribution](image-url)

**Main encroachers**
- *Dichrostachys cinerea* subsp. africana
- *Acacia reficiens* subsp. reficiens
- *Acacia mellifera* subsp. detinens
- *Combretum collinum* (in areas of eastern Omaheke Region)
- *Acacia hebeclada* (in areas of eastern Omaheke)
- *Acacia nilotica* subsp. nilotica
- *Prosopis sp.* (black wattle – a patch in Otjozondjupa)

**Less important as encroachers**
- *Terminalia sericea* (in areas of eastern Omaheke/ Otjozondjupa)
- *Terminalia prunoides* (in areas of eastern Omaheke)
- *Terminalia superba* (in areas of eastern Omaheke)
- *Terminalia obovata* (in areas of eastern Omaheke)

**Invasive species**
- *Prosopis sp.* (black wattle – a patch in Otjozondjupa)
- *Terminalia superba* (in areas of eastern Omaheke)
- *Acacia nilotica* subsp. nilotica

**Table 1** Species and ecological roles

<table>
<thead>
<tr>
<th>Main encroachers</th>
<th>Less important as encroachers</th>
<th>Invasive species</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Dichrostachys cinerea</em></td>
<td><em>Combretum collinum</em> (in areas of eastern Omaheke Region)</td>
<td><em>Prosopis sp.</em> (black wattle – a patch in Otjozondjupa)</td>
</tr>
<tr>
<td><em>Acacia reficiens</em> subsp. reficiens</td>
<td><em>Acacia hebeclada</em> (in areas of eastern Omaheke)</td>
<td><em>Terminalia sericea</em> (in areas of eastern Omaheke/Otjozondjupa)</td>
</tr>
<tr>
<td><em>Acacia mellifera</em> subsp. detinens</td>
<td><em>Acacia nilotica</em> subsp. nilotica</td>
<td><em>Terminalia superba</em> (in areas of eastern Omaheke)</td>
</tr>
<tr>
<td><em>Combretum collinum</em> (in areas of eastern Omaheke Region)</td>
<td><em>Prosopis sp.</em> (black wattle – a patch in Otjozondjupa)</td>
<td><em>Acacia nilotica</em> subsp. nilotica</td>
</tr>
</tbody>
</table>

**Figure 2.1 - Species and ecological roles**

Targeting the main encroacher species for the development of end-use products, particularly the Acacia species, the above map and available local level data enhance planning to optimise efficiencies and reduce costs. The value chain that delivers the raw material at the plant is a major factor in determining time to market. From the above map, the distribution of the Acacia mellifera, which has shown resounding success so far as a main animal feed ingredient, overlaps with Otjozondjupa, where the plant would be situated. The MAWF/GIZ phase 2 project on Bush Management and Bush Control (BMBC) corroborated that tree equivalents per hectare (TE/ha) ranging between 4,000 to 12,000 overlap Khomas, Otjozondjupa, Kavango East and West, and the four central regions of the country. The species that overlap here (see above) include: A. mellifera (subspecies detinens) and A. reficiens (subspecies reficiens), Terminalia prunoides and sericea, and Dichrostachys cinerea. It is also estimated that biomass of 4.50 million tonnes could be accessed for bush-based value chains, not accounting for annual growth at 3.14%, signalling sustainability.
2.2 BUSH BIOMASS - SUITABILITY FOR FEED

All the above species (A. mellifera, A. reficiens, Terminalia pruinoides, Terminalia sericea and Dichrostachys cinerea) have been analysed for their nutritional and mineral properties (see table below for illustrative purposes) and, based on these data, have been used in the formulation and testing of bush-based animal feeds.

<table>
<thead>
<tr>
<th>Species</th>
<th>Moist Ash</th>
<th>Fat</th>
<th>CP</th>
<th>CF</th>
<th>ADL</th>
<th>NDF</th>
<th>Ca</th>
<th>P</th>
<th>OMD</th>
<th>ME</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. mellifera milled</td>
<td>4,67</td>
<td>6,17</td>
<td>0,05</td>
<td>0,49</td>
<td>58,31</td>
<td>62,41</td>
<td>76,74</td>
<td>1,47</td>
<td>0,02</td>
<td>32</td>
</tr>
<tr>
<td>D. cinerea</td>
<td>6,49</td>
<td>6,11</td>
<td>1,09</td>
<td>10,7</td>
<td>33,17</td>
<td>49,84</td>
<td>56,66</td>
<td>1,15</td>
<td>0,25</td>
<td>47,2</td>
</tr>
<tr>
<td>A. mellifera in tree</td>
<td>6,71</td>
<td>6,81</td>
<td>1,77</td>
<td>8,03</td>
<td>35,35</td>
<td>45,94</td>
<td>54,27</td>
<td>1,46</td>
<td>0,28</td>
<td>43,5</td>
</tr>
<tr>
<td>A. mellifera 2m bush</td>
<td>5,42</td>
<td>5,92</td>
<td>2,77</td>
<td>16,9</td>
<td>33,21</td>
<td>41,37</td>
<td>48,58</td>
<td>0,83</td>
<td>0,02</td>
<td>53</td>
</tr>
<tr>
<td>A. mellifera 16 months</td>
<td>6,86</td>
<td>11,13</td>
<td>3,15</td>
<td>13,5</td>
<td>24,7</td>
<td>29,56</td>
<td>39,21</td>
<td>1,32</td>
<td>0,3</td>
<td>62</td>
</tr>
<tr>
<td>A. secons seed feed</td>
<td>4,54</td>
<td>5,61</td>
<td>2,24</td>
<td>17,55</td>
<td>27,77</td>
<td>25,12</td>
<td>32,27</td>
<td>0,5</td>
<td>0,07</td>
<td>61,5</td>
</tr>
<tr>
<td>T. sere A</td>
<td>4,76</td>
<td>8,8</td>
<td>2,56</td>
<td>9,75</td>
<td>24,15</td>
<td>34,54</td>
<td>49,04</td>
<td>2,05</td>
<td>0,07</td>
<td>38,2</td>
</tr>
</tbody>
</table>

Based on the nutritional and mineral analyses, bush material is found to be superior in terms of its crude protein (CP) (average of approximately 13,5% g/kg), although there is need to be wary of properties (e.g., tannins, woodiness, and fibre) that could result in toxicity and/or unpalatability (see text below). The five species proved viable for animal feed based on the feeding trial data and as briefly described above. This availability of a variety of species suitable for animal feed avoids the risk of reliance on one species and improves sustainability. The five species, along with supplements and additives, can deliver a wide array of animal feed recipes for field testing (e.g., complete feed, drought supplement, growth enhancer).

![ANIMAL FEED](image)

**Figure 2.4 - Illustration of the zero-waste approach to use an entire encroacher bush**

As mentioned above, production of animal feed is a specialised process, comprising the combination or blending of ingredients to deliver a well-balanced product palatable for target animals. Traditionally, bush biomass has not been used and is not yet mainstreamed in regionsally and globally marketed animal feeds. Based on the 2018 AllTech Global Feed Survey, soybeans, wheat, and maize are still the base components of most animal feeds. Hence, considering bush biomass for animal feed requires a rigorous scientific and investigative process to ensure that bush-based feeds meet national and international standards and do not present a risk of any negative effects on animal health. The text below describes pertinent elements that this project has been investigating and would continue to investigate to deliver high quality, reliable feed.

**FIBRE CONTENT**

Fibres influence animal nutrition because their soluble and insoluble forms influence nutrient availability since they are partly fermentable and non-fermentable and influence intake and digestibility. In nature, 50% of animal diets comprise the non-starch polysaccharide (NSP)-fibres. The solubility of the NSP-fibres depends on the feed raw material as both insoluble and soluble fibres play important roles in the gut of an animal. Soluble fibres are involved in viscosity development in the small intestine, a role that is considered anti-nutritional as it limits efficient absorption of nutrients, while on the other hand it can play a role to increase the intestinal villi health of an animal.

At present, under prevailing legislation, animal feed with fibre content not exceeding 68% can be registered. Namibian authorities assume that 68% bush material equates to 68% fibre, whereas measurements by UNAM and GIZ suggest that this fibre content is about half of the total biomass, i.e., for 68% bush the fibre content can be safely assumed to be 34%. For the five species mentioned above, the crude fibre (CF) measurements range between 20 and 60% (see Fig 2.2: column “CF”) for twigs and leaves < 20 mm, whereas CF above 70% has been recorded where bush material > 20 mm has been used. At an average of 40% fibre, bush-based feeds would offer a close comparative to commercial mainstream feeds which have up to 50% NPS-fibres.

This project engages in ongoing sampling and monitoring to improve the knowledge and data about fibre content in bush and variation among species and within species due to variation in soil conditions. Research will also aim to find, like tannins (discussed below), fibre content increases or decreases with diameter size above or below 20 mm.

**TANNINS**

Tannin (or tannoid) is a yellowish or brownish bitter-tasting organic substance present in barks, twigs, and other plant tissues, consisting of derivatives of gallic acid. Tannins are generally toxic to ruminants but also serve a beneficial purpose by binding to proteins and protecting them from rumen fermentation, enabling better dietary use of proteins. A. mellifera bush-based feed with tannin levels of between 5-10% has shown positive results during feeding trials as reported by UNAM, GIZ, and a private farmer. In some cases where bush material > 20mm was used, negative effects were observed in livestock, including bloating and death. Development partners agree that more research and sample analyses are required to better understand the role of tannins and how best to regulate the concentration in animal feed. Tannins with high pH values (acids) have negative effects on the rumen, while lower pH values (more alkaline) are better suited.

To make a distinction between these effects and to apply them properly to species selection and processing of leaves together with twigs, it is recommended that species that are considered promising be analysed for tannin content in leaves and twigs. Therefore, the next step will be to investigate in which species tannin has a favourable or negative effect, for which pH measurements may be an acceptable tool to determine maximum acceptable acidity values and desirable alkalinity values, as noted above.

More tannin sample data are needed for the feed-favourable encroacher species and to know what the regulation of tannins could mean. In the case of one of the major animal feed producers in Namibia, an ox died due to tannin poisoning as material > 20 mm was milled and blended as animal feed. The contents of the rume were found to be black.

UNAM, in partnership with Szczecins University of Applied Sciences, is continuing research and investigations that would also form part of the monitoring and data recording during recipe development and feeding trials.

From the above, one can summarise that:

- Bush material < 20 mm is suitable for animal feed due to higher nutritional and mineral values, lower tannin concentration, and nutritious fibre content that can be regulated depending on the feed type.
- For optimal nutrition and mineral content in feed, it’s best to harvest during the rainy season as sampling shows the best values during this time.
- Fibre content up to 50% is comparable to that in commercial feeds while Namibian legislation does not allow registration of feed with fibre above 68%.
- Tannins are toxic to ruminants but are beneficial at the optimal concentration as they lend with proteins for more efficient dietary uptake.
- More research and field trials are needed to calibrate fibre and tannins in animal feed.
- A long-term dedicated research, monitoring, and evaluation programme is needed to develop a database on the process of designing and testing bush-based animal feed.
3 Targeted Bush-processing Value Chains

3.1 INTEGRATED ZERO-WASTE FEED-CHARCOAL PRODUCTION  32
3.2 ASSESSMENT OF THE TARGETED VALUE CHAINS  36
3.3 FURTHER BUSH VALUE CHAINS TO BE EXPLORED  37
MAWF/GIZ conducted extensive research and analysis to determine a total number of possible bush-processing value chains (15) and to narrow that down to a number that is achievable. Fourteen (14) were identified and a 15th, Arabic Gum, was added by this project, given regional and global trends in production, demand, supply, and application. The figure below presents the 15 most viable value chains.

<table>
<thead>
<tr>
<th>Value Chain</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charcoal</td>
<td>From the list of 15 value chains, two were selected for intensive evaluation parameters below were considered.</td>
</tr>
<tr>
<td>Wood Chips</td>
<td>Biomass energy has taken off in Namibia while elsewhere, for example the 4.0 Watt Drax biomass plant in the United Kingdom, demand exists and is mounting for sustainable supplies of large volumes of biomass. Power plants like Drax have started surveying the world for future biomass supply to sustain operations.</td>
</tr>
<tr>
<td>Compressed Firewood</td>
<td>Of the above value chains, some have been implemented for decades (e.g., charcoal), others can take off with ease (poles and wood chips), some more specialised ones are emerging with success (wood-plastic composites) while other more specialised ones require more time and resource investment before implementing (MDF and WCB products). Commercial-scale charcoal has been produced in Namibia since 1983 with the emergence of Jumbo Charcoal, while end-uses such as firewood, wooden poles, and traditional medicines have been fabricated since time immemorial.</td>
</tr>
<tr>
<td>Firewood</td>
<td>The demonstration phase would invest ample time and resources to refine the competitiveness and to ensure quality.</td>
</tr>
<tr>
<td>Animal Feed</td>
<td>Product competitiveness has been a key consideration throughout the viability analysis since it is a critical signal for business viability and sustainability. Competitiveness relates to:</td>
</tr>
<tr>
<td>Wood Pellets</td>
<td>MARKETS FOR END PRODUCTS AND ASSESSED BENEFITS</td>
</tr>
<tr>
<td>Poles</td>
<td>Each of the two end-products (animal feed and charcoal) was assessed for its market value, which is based partially on the provision of the quality required to attract consumers/retailers and to assure a sustainable market position. Hence, there is need to establish “acceptable foreseen quality” and to market the benefits as evidenced by feeding trial data, in the case of animal feed. For charcoal, there exists firm market value: the benefits of the product are known and understood; there exists willingness to pay.</td>
</tr>
<tr>
<td>Wood-Cement Bonded (MDF) Products</td>
<td>In the case of bush-based animal feed, there exists some preliminary market value due firstly to the historical use of bush material as feed or feed supplements, and secondly due to the increasing use of bush material as feed, even outside periods of drought. Market value is driven by product quality, which in the case of bush-based feed hinges on the nutritional and mineral values of bush species and the ensuing positive results from feeding trials (i.e., assessed benefits). Market value and benefits were further confirmed, although anecdotally, by a farmer who produces bush feed comprising 85% bush and has observed massive demand for the feed from surrounding farmers.</td>
</tr>
<tr>
<td>Medium Density Fiber (MDF) Products</td>
<td>Eco-labeling/branding of the products – for example, “Sustainably Harvested Encroacher Bush” or “Value-Added Bush to Recover Rangelands” – and/or putting the nutritional values and/or publicising feeding trial data could unlock regional and global markets, expansion which would increase the general market value.</td>
</tr>
<tr>
<td>Wood-Sap Boards</td>
<td>COMPETITIVENESS OF END PRODUCTS</td>
</tr>
<tr>
<td>Wood Plastic Composites (WPC)</td>
<td>Product competitiveness has been a key consideration throughout the viability analysis since it is a critical signal for business viability and sustainability. Competitiveness relates to:</td>
</tr>
<tr>
<td>Parquet</td>
<td>1. Market demand – existing and/or potential for a variety of existing products – more affordable, etc.;</td>
</tr>
<tr>
<td>Shingles</td>
<td>2. Pricing – compared to competitors with market share and based on market standards for volume (e.g., 50kg bags) at competitive prices (N$200-250/bag). In the case of bush-based feed, there are additional proven benefits that deliver “greater value for money” – daily weight gains possible with the feed and the added benefit of restoring rangelands;</td>
</tr>
<tr>
<td>Traditional Medicine</td>
<td>3. Quality – trial recipes show great potential to deliver quality that is comparable to or even better than what is available in the market. Quality is well-defined in the global animal feed sector in references such as the “2007 Feed Ingredients Standard for Producers and Processors of Feed Ingredients” and in the advice and guidance offered by the UN FAO Department for Agriculture and Consumer Protection.</td>
</tr>
<tr>
<td>Arabic Gum</td>
<td>Based on the feeding trials conducted thus far and the fact that farmers continue to invest in technology that can assist them with de-bushing and the utilisation of such bush, the eventual product is assumed to be competitive based on the following:</td>
</tr>
</tbody>
</table>

Of the above value chains, some have been implemented for decades (e.g., charcoal), others can take off with ease (poles and wood chips), some more specialised ones are emerging with success (wood-plastic composites) while other more specialised ones require more time and resource investment before implementing (MDF and WCB products). Commercial-scale charcoal has been produced in Namibia since 1983 with the emergence of Jumbo Charcoal, while end-uses such as firewood, wooden poles, and traditional medicines have been fabricated since time immemorial.

3.1 INTEGRATED ZERO-WASTE FEED-CHARCOAL PRODUCTION

From the list of 15 value chains, two were selected for intensive viability analysis and for actual demonstration in 2019. To arrive at these two value chains, the evaluation parameters below were considered.

BUSINESS BIOMASS TO PRODUCT – RAW MATERIAL SELECTION

Only nationally identified and recognised encroacher bush will be targeted. For bush feed, some encroacher species (e.g. melinis) fare better than others, based on feeding trial data. Mentioned above is the fact that leuers and twigs < 0.2mm in diameter are most suitable for feed, and harvesting during the rainy season optimises the nutritional and mineral properties important for well-balanced feed. The harvesting of material suitable for feed production requires more care than species-specific concentrate bush harvesting for fuel for combustion purposes.

Harvesting cost is affected by the type of harvesting, the terrain, and the distance from the processing site.

There is a need for species selection criteria that extend to the size of the material needed for feed compared to that needed for charcoal. The N-Big has estimated M1700/ tonne as a reasonable price for raw material supply, which is worth noting and considering. N-Big also provides a service on behalf of reputable and proven de-bushing entities to harvest and supply raw material.

IMPACT OF BUSH BIOMASS UTILISATION ON BUSH ENCROACHMENT

This project is developing a business model that would deliver triple wins, one of these “wins” being the restoration of rangelands. Recalling the MAWF/GIZ assumption that 60% of the total encroached area can be targeted, harvesting 5% (778,000 tonnes) per year could result in a 67% reduction of encroacher bush over a 20-25 year period (assuming no follow-up measures). Based on most recent scientific evidence,10 this magnitude of restoration would be achievable only with carefully planned and implemented follow-up measures aided by a “contouring method” of harvesting, i.e., thinning encroacher bush in rows such that alternating rows are left unattended. It is critical to consider and factor in the annual bush growth at 3.18%.

The proposed Integrated Feed-Charsal Production (IFCP) System would have a zero-waste approach to the use of each bush harvested: 20% of the raw material would be for feed and 80% for charcoal. An initial target of 4,444 metric tonnes of feed was set for 2019, only for demonstration purposes. This goal implies that the harvested biomasses must be at least 5 times the volume for feed to deliver the above feed-to-charcoal ratio. Hence, the total biomass required would be 22,220 metric tonnes (mt) per year, of which 17,716 mt (80% of total biomass) would be reduced to charcoal.

10 Zimmerman, I. et al. (2017) “The influence of two levels of de-bushing in Namibia’s Thornbush Savanna on overall soil fertility, measured through bioassays.”
It is currently estimated that 45 million ha are bush-encroached and that this area translates into 450 million tonnes of biomass. Over a 25-year period, this biomass would provide 18 million tonnes of harvestable biomass per year. Feedmaster, Namibia’s only animal feed manufacturer, delivers some 160,000 mt of feed per year.

Assuming an extended RCP production would commercially deliver between 30,000-50,000 mt of feed per year – to be competitive in the domestic market, this would translate into a total harvest of 150,000-250,000 mt per year. At this scale, the impact on reducing bush encroachment would be 1.4% per year of the 18 million tonnes of harvestable biomass after taking advantage of a certain multiplier effect.

Based on the existing biomass of mukweha bushes and the annual growth rate, this project, the MAWIT-GIZ project, and N-8-Big, all estimated that up to 20 such operations could viably and sustainably exist in Namibia and together would deliver the impact required to reduce bush significantly and carry out extensive follow-up measures to restore rangelands. Furthermore, joint efforts would help to sustain the natural biodiversity and natural aesthetics, which support the tourism sector.

Creating employment will be an important outcome from efforts to significantly reduce bush encroachment, particularly as one of the “triple-win” social benefits. Here it is considered what types of employment could be created by the emerging bush processing sub-sector in general and specifically for the manufacture of animal feed and charcoal.

<table>
<thead>
<tr>
<th>Type of Employment</th>
<th>Raw material supply</th>
<th>Raw material cleaning</th>
<th>Processing</th>
<th>Product development</th>
<th>Packaging and branding</th>
<th>Warehousing</th>
<th>Marketing and sales</th>
<th>Adm./Mgt.</th>
<th>Est. number per operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unskilled to semi-skilled (50-70%)</td>
<td>15</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>23</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Semi-to fully-skilled (15-25%)</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skilled to tech. competencies (5-15%)</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 3.2 above breaks down the value chains into different steps in a logical sequence, starting with refining or improving the raw material and ending with the delivery of an end-use product. The figure indicates the type of employment created, the potential number of people in that category needed to perform the various steps, and the estimated total of each type for the overall operation. Since the above-stated demand requires 30,000-50,000 mt of feed, employment creation has to be multiplied accordingly.

The profiles of the types of employment are as follows:
- 77% unskilled to semi-skilled – e.g. school drop-outs with technical competencies, general labourers with or no limited technical training, the general unemployed and those with capacity for learning;
- 17% semi-to fully-skilled – e.g. certified to uncertified technicians/artisans such as boiler makers, millers, food technicians, processing and production technicians;
- 7% fully skilled to technical competencies – first or second degree holders with experience in project/ value chain/supply chain/project management, or certified and experienced (more than 7 years) millers, processing and production technicians.

The consideration of employment creation is critical from a national development priorities perspective since national unemployment is at 28% with youth unemployment at 43%. The youth comprise more than 60% of the Namibian population, with capacity development and training, youth can be prepared to contribute to inclusive and sustainable industrial development.

The above employment projection is based on an industrial, technologically advanced production process that requires minimal human resources at the production plant (see section on business model and planning). This technology and the RCP system have been chosen to enable large-scale bush thinning to lead rangeland restoration. Hence, the short- to medium-term focus is to generate mass employment in harvesting, pre-processing, and processing materials.

The Acacia tree is known for both its ecological and economical importance. It is a valuable source of food, such as the seeds that are used as flour, as well as an energy source in terms of timber and other uses. With the growing market of Arabic gum, its importance has increased and numerous initiatives were launched for planting of Acacia trees to address climate change and desertification challenges. Such initiatives have also helped farmers by providing additional jobs as the Arabic gum harvesting is a labour-intensive process, thereby also facilitating increased production in a systematic way throughout the value chain. As an example, Arabic gum sales have been an important source of income for about 6 million Sudanese, mainly small farmers. At the same time, the income of such producers could drastically increase through improved access to technologies and cooperative modalities among farmers to facilitate scale of production with better access to external markets, thereby providing an opportunity to improve the livelihoods of the poor and address the poverty in the country.

<table>
<thead>
<tr>
<th>Multiplication Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effectiveness in addressing/tackling bush encroachment;</td>
</tr>
<tr>
<td>Multiple sustainable development benefits – water, energy, food security, drought/ climate change resilience;</td>
</tr>
<tr>
<td>Generation of sustainable employment and decent incomes.</td>
</tr>
</tbody>
</table>

12 Africh 2010 Global Animal Feed Production Survey.
3.2 ASSESSMENT OF THE TARGETED VALUE CHAINS

**Critera**

- **Animal Feed**
  - Most encroacher bush species are suitable for bush feed – <20 mm diameter leaves and branches, some succulent to succulent nutrition.
  - Ongoing research on legume, trees, and palatability properties.

- **Charcoal**
  - The market value of the intended animal feed production is guaranteed by already available commercial charcoal producers (limited to 1 producer), which means that demands is placed. Already existing production is of significant importance due to the influence on the shortage in the time-to-market period and would contribute to immediate sales.
  - Charcoal has an already developed market with confirmed market value and an annual demand of 150,000 tonnes.
  - Potential exists for high margins, value-added charcoal-based goods, e.g., biomass, which is valorised as charcoal with several high-value applications as filter materials, as a pharmaceutical product (white charcoal), and after undergoing a torrefaction process, as a second-generation fuel. These markets are currently not developed in Namibia.

- **Solid Biomass Fuel**
  - Limited sales experiences and evidence of “willingness to pay” are in place and suggest a potential strong competitive position with respect to currently produced blended bush-based animal feed products.
  - With bush as the major input material, the cost of which depending on harvesting cost, one could assume reasonable margins can be obtained with current bush-based feed.
  - In addition to competitive pricing, bush-based feed would be a win-win offer to the agricultural sector – providing feed and enabling rangelands restoration – this should be marketed part of shifting.
  - Publishing of feeding trial data and nutritional and mineral properties of bush material should be in establishing a competitive reputation from the onset.

- **Sustainable Biomass**
  - Limited market for solid biomass within Namibia with solid research indicating continuous production.
  - Market value of the intended animal feed production is guaranteed by already available commercial charcoal producers (limited to 1 producer), which means that demands is placed. Already existing production is of significant importance due to the influence on the shortage in the time-to-market period and would contribute to immediate sales.
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3.3 FURTHER BUSH VALUE CHAINS TO BE EXPLORED

The figures below (Figures 3, 5a, and 5b) show analyses of additional value chains that can be viable in Namibia with solid research and development, an excellent blend of skills and expertise, and investment capital.

**CRITERIA**

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  - Ongoing research on legume, trees, and palatability properties.

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CHAPTER 3: TARGETED BUSH PROCESSING VALUE CHAINS
potential competitiveness of end-products

• Namibian National Integrated forestry Plan (NNIP) – essentially the roadmap for energy security – indicates 4 biomass power plants at 20MW each by 2024, 2026, 2028, and 2033. Although it is not mentioned in the NNIP, the Namibian power utility is in the process of focusing on a techno-economic analysis for the first 20MW biomass power plant which is estimated to use 160,000 metric tonnes of biomass per year.

• In addition to NNIP plans, there is an opportunity to replace the Ohorongo Cement plant model at Otjikandero, which is diagonally across the road intended for the project’s demonstration. Ohorongo uses around 45,000 metric tonnes of biomass per year.

• Based on the current Ohorongo Cement example of using 45,000 metric tonnes of chipping, roughly equal to 10,800 hectares, and additional 20,600 metric tonnes for the beer brewing process, 160,800 metric tonnes for the 20MW power plant per annum are estimated and could be configured in future with Cheetah Cement and the biomass power plants in the NNIP.

• Ohorongo, the brewery, and NamPower would use a total of 20,600 metric tonnes, equating roughly to thinning on an area of 24,500 ha. If Cheetah establishes a power plant in future at a scale similar to Ohorongo, this could equate to 105,000 tonnes per year, or 5,250 ha.

• This would require only 6% of the 5% harvesting rate supported by the NamPower GIZ to reduce biomass encroachment by 5% over 20 years. This was based on a theoretical 50% output of 25,000 ha.

• The limited scale of the forestry and thinning discussion suggests this is not a viable revenue channel and would not significantly impact remuneration by thinning encroacher bush.

- The limited scale of the forestry and thinning discussion suggests this is not a viable revenue channel and would not significantly impact remuneration by thinning encroacher bush.

- With Cheetah Cement as an example, and with increased access to affordable biomass power technology, the time to market is reasonable (6–18 months) given the growing market and available technologies that could be employed. With >60% household in rural Namibia headed by women, through integration of local labor, the example suggests 1,200 people could be employed. With >60% households in rural Namibia headed by women, through integration of local labor, the example suggests 1,200 people could be employed. With more than 25% of the population being women, the employment potential is significant.

- For example, Cheetah Cement operates out of Otjikandero (approximately 90,000 ha) and could replicate the Ohorongo model to improve production efficiencies and to lower costs.

- Cheetah’s power plant has limited potential for export, unless manufacturing contracts are agreed and supported by an external partner where well-developed markets exist.

- Based on the condition of the existing technology to manufacture MDF thin boards, the time to market could be significant, i.e., 6–18 months. The technology is not suitable, the time to market could be 24–36 months, once a product would be achieved and financed for commercial operations.

- Wood Plastic Composites (WPC) are being manufactured and could serve as a learning lessons for the additional production plants. Given the growing awareness of WPC’s environmental friendliness, the time to market could be 36 months at most.

- The main crop is harvested between December and April. Gum production can begin when the trees are 5 years old although gum may be picked from the tree at any time. However, the quality and yield are consistent only after 5 years.

- Important for Namibia is the availability of Acacia gum producing species to be harvested, and therefore, the time to market could be 36 months at most.

- Gum is harvested from harvest trees that source locally but mainly import. The informal local-based market consists of farmers/individuals who produce gum to generate income.

- A feasibility study should be done (a) to ascertain the possibility of producing wood poles at a scale to become competitive through intensive investment, or (b) for one or two entreprenues to source poles from various suppliers and connect this to high-quality wood to retailers while serving low-standard users to private persons at a discounted price, similar to the current practice in charcoal processing.

- The new method will also assess the problem of transportation cost due to the small demand is distributed over significant territory.

- Wood poles are mainly imported. Local production would entail technology to ensure straightness, length, and outsize diameters. Hence, a good volume of poles produced would be significant raw material waste.

- Gum production is important. Local production would entail technology to ensure straightness, length, and outsize diameters. Hence, a good volume of poles produced would be significant raw material waste.

- The gum industry is expected to produce poles and the realistic volume of usable poles that can be produced per year. This product is not expected to deliver significant impact on the reduction/eradicating encroacher bush.

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International Development Efforts: Synergies and Coherence

4.1 DEUTSCHE GESELLSCHAFT FÜR INTERNATIONALE ZUSAMMENARBEIT (GIZ) 42
4.2 UNITED NATIONS DEVELOPMENT PROGRAMME/MAWF PROJECT 43
4.3 UNIVERSITY OF NAMIBIA (UNAM) 43
Searching for synergies with sectorial strategy and considered as a complementary tool for implementing national policy for sustainable development, this study considers the research and technical activities conducted so far by the national and international development partners, which are briefly described in this Chapter.

4.1 DEUTSCHE GESSELLSCHAFT FÜR INTERNATIONALE ZUSAMMENARBEIT (GIZ)

GIZ has been working in Namibia on behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ) and the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) since the country gained its independence in 1990. The Programme Competitiveness for Economic Growth supports the Government of Namibia in implementing the policies described above. It focuses on growth strategies for selected economic sectors, as well as financial systems development and capacity development in the institutions involved. It is complemented by the related GIZ project for the promotion of vocational education and training. Led by the Ministry of Industrialisation, Trade, and SME Development, the Financial Literacy Initiative is designed to address access to finance for Namibian enterprises, several reforms for instance through the simplification of processes, incentive schemes, and access to local and regional markets. These measures benefit all businesses and sectors in the country. Public-private dialogue is similarly important, so the project supports NCCI in its role as an industry association.

To improve that access for Namibian enterprises, several reforms for instance through the simplification of processes, incentive schemes, and access to local and regional markets. These measures benefit all businesses and sectors in the country. Public-private dialogue is similarly important, so the project supports NCCI in its role as an industry association.

The project conducts two studies estimating the net benefits of bush encroachment, compared with a scenario of no action on bush encroachment. Both studies were undertaken by Namibia Nature Foundation (NNF) from February 2016 to February 2017. The studies provided initial economic valuations to guide policy options when acting on bush encroachment. Various ecosystem services on national and regional levels were valued and analysed with a cost-benefit model. The potential net benefits on the national scale were estimated at N$8.0 billion over a 25-year period.

In case of the study on the Oshandonzupa region, the net benefits were estimated at N$4.9 billion. Additional groundwater replenishment accounted for most of the valuation; however, there would also be benefits for livestock production, tourism, biodiversity, biomass-powered electricity generation (and associated carbon offsets), and value addition opportunities such as the production of charcoal, firewood, and animal feed. The findings of the studies clearly show that bush control can make a considerable contribution to Namibia’s welfare and economic growth in terms of employment and other social-economic benefits. Moreover, the regional case studies contribute greatly to the MET Land Degradation Neutrality pilot project in Oshandonzupa and complements the MRU Integrated Land Use Plans, particularly regarding the related strategic environmental assessment (SEA).^14

4.2 UNITED NATIONS DEVELOPMENT PROGRAMME/MAWF PROJECT

The UNDP/MAWF- and GEF-financed project, NAFOLA, is a five-year project that has been supporting the gazetting of community forests and strengthening management through capacity development and fostering ownership of local forest resources. The NAFOLA Project targets 11 registered/emerging community forests to improve the management of forest resources. In 7 of the 11 sites, bush encroachment is extensive and a major challenge for indigenous trees and palatable grasses. Output 2.5 of this project directly targets bush encroachment as a threat to indigenous trees, plants, grasses, and even to endemic animal wildlife. By improving the management plans of community forests, the project has been assisting with de-bushing strategies to improve the integrity of the wooded grasslands and forests without unintentionally causing additional damage to forest ecosystems. The project has assisted communities in identifying ways to convert bush materials into sustainable products for income generation. Potentially marketable products include charcoal and briquettes, fuel wood, and other wood products. With this aim in view, the project procured a bush-processing machine and piloted into produce livestock feed. Through the MAWF-GIZ partnership to strengthen the restoration of productive rangeland in Namibia by identifying value chain opportunities to trigger large-scale de-bushing activities, the project was able to carry out feeding trials using the bush-based feed in the African Wild Dog community forest. The main outputs of this exercise included:

- A research report providing scientific evidence and elaborating the nutritional value of different bush species, and suggesting the most suitable bush-based feed diet according to the present ENCROACHER bush species and the available supplements;
- A farmer’s manual on bush-based animal feed production in a communal setting;
- An agricultural case for commercial production of bush-based animal feed production and storage;
- A research paper for publication in a peer-reviewed scientific journal will also be considered after the research report is completed and the project has ended.

4.3 UNIVERSITY OF NAMIBIA (UNAM)

The Faculty of Agriculture and Natural Resources hosts various departments dealing with animal nutrition and health sciences. This Faculty is involved in research and development pertaining to the use of encroacher bush material for conversion to animal feed. The Faculty technically supported MAWF, local farmers in the Omahake region, and the NAFOLA Project with trials to test bush-based feed variations. UNAM carries out nutritional and mineral analyses of bush biomass and provides advice on additives and supplements to enable delivery of a well-balanced, palatable livestock feed.

4.4 SEINÄJOKI UNIVERSITY OF APPLIED SCIENCES

Seinäjoki University of Applied Sciences (SeAMK) is a multidisciplinary university of applied sciences that offers education, research, and development and innovation (RDI) in the region of South Ostrobothnia in West Finland. Since 2016, SeAMK has carried out several studies focusing on the feed use of Acacia fractions in Namibia, the Bank of Namibia, and the NAFOLA Project, including a feasibility study that produced promising results. After the first analysis, for instance, the protein concentration of the fine fractions (fines) was on a level of grams. The cooperation with UNIDO on a feasibility study on the compound production of fishmeal and animal feed for rural and urban settings has carried out various forging of innovation, including the development of the bush raw material harvesting, identification of technology and human capacities requirements for operationalization of the project to be delivered.

A second phase (2018-2020) focuses on encroacher bush management and bush control (BMRC). This includes the application of information and data about bush species and their distribution, resident topography, as well as mineral and nutritional values in order to refine the feasibility assessment of additional value chains. To this end, the project also supports adapting the existing policy and legal environments to serve an enabling role instead of posing additional challenges.

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^14 www.dasnamibia.org

^15 Sustainable Management of Namibia Forested Lands, financed by the Global Environment Facility.
## Contents

### 5.1 Current Status and Trends of Bush-Feed Production
- 5.1.1 Bush control and harvesting methods
- 5.1.2 Bush chipping
- 5.1.3 Drying
- 5.1.4 Milling
- 5.1.5 Mixing/Blending
- 5.1.6 Pelletizing
- 5.1.7 Recipes and end-products
- 5.1.8 Summary of current practices and trends

### 5.2 Current Status and Trends of Charcoal Production
- 5.2.1 Charcoal: origin, uses and characteristics
- 5.2.2 Namibia Charcoal Association (NCA)
- 5.2.3 Jumbo charcoal
- 5.2.4 Makarra bush products
- 5.2.5 Traditional drum kiln versus retort system

### 5.3 Integrated Feed-Charcoal Production System
- 5.3.1 Containerised feed mill
- 5.3.2 Containerised retort system
- 5.3.3 High-margin charcoal products
- 5.3.4 Industrial approach: Project implementation

### 5.4 Technology Appropriateness and Sustainability
- 5.4.1 Functional appropriateness
- 5.4.2 Durability, serviceability and parts replacement
- 5.4.3 Affordability and replacement cost
- 5.4.4 Replicability, assembly or local manufacturing
- 5.4.5 Impact of this technology
- 5.4.6 Research and Development

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Production System, Technology Appropriateness and Sustainability
5.1 CURRENT STATUS AND TRENDS OF BUSH-FEED PRODUCTION

For the following evaluation and assessment of the proposed production system and technology, an individual approach is elaborated as the baseline production system and technologies in use. The process steps to convert bush to animal feed as end-product are the same for the individual and industrial approaches, with differences in the scale of economic opportunities, professional staff requirements, and specialised equipment suited to the respective production capacities, optimised business processes, and accompanying management challenges.

5.1.1 Bush control and harvesting methods

Addressing bush encroachment in Namibia has led to an array of solutions under experimentation that, until recently, were mainly to simply get rid of the bush as fast as possible with as little cost and effort as possible. Over the past decade, more attention has gone not only to the disposal of the harvested wood biomass, the follow-up measures into the impacts of bush control/harvesting/thinning, extended to the handling of the biomass as an energy source, but also to the larger environmental and ecosystem impacts. In the past five years, bush control has been considered from a business point of view, especially when high-tech machinery came into play and some existing value chains started to grow and diversify.

This section looks specifically at harvesting as a significant cost factor with respect to economic viability. Mechanised harvesting will have to be justified by product competitiveness, while factors such as topography, terrain (mountainous vs. sandy flats), and favoured species distribution can affect the mass balance of harvestable bush areas.

The "Bush Control Manual"16 published by the MAWF/GIZ in 2017 describes all the current practices and provides useful insights as summarised in the below table.

<table>
<thead>
<tr>
<th>METHOD</th>
<th>DESCRIPTION</th>
<th>EQUIPMENT</th>
<th>COST (ESTIMATE/N$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manual</td>
<td>Manual bush control is achieved by hand labour using hand tools:</td>
<td>Axes, panga, and spades</td>
<td>1,000 – 3,000/ha</td>
</tr>
<tr>
<td></td>
<td>only. Highly selective and effort intensive.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Semi-mechanised</td>
<td>This form of bush control involves the use of hand-held power</td>
<td>Conventional bush cutter, heavy-duty bush</td>
<td>1,500 – 2,000/ha</td>
</tr>
<tr>
<td></td>
<td>tools, with a power cutter, and a hand-held tools, such as axes,</td>
<td>cutter, and chain saw.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>which is highly selective with faster rate of control at lower</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>man-hours.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanical</td>
<td>This form of bush control is achieved with the use of self-</td>
<td>Heavy mechanical cutting machine with loppers,</td>
<td>750 – 4,000/ha</td>
</tr>
<tr>
<td></td>
<td>propelled machinery equipped with various appliances.</td>
<td>small bulldozer, circular saw, heavy bulldozer,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Selectivity varies with the size and sensitivity of control of</td>
<td>and bush roller.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>the harvesting appliance, which can clear vast tracts of land in</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a short time.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemical-manual</td>
<td>Chemical-manual applications of arboricides are used most</td>
<td>Pump sprayers and by hand.</td>
<td>500 – 2,600/ha</td>
</tr>
<tr>
<td>application of</td>
<td>frequently and one effective when correctly used.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>arboricides</td>
<td>Harbicides and arboricides are used most frequently and one</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>effective when correctly used.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Planned fire</td>
<td>Frequently unable to control well-established dense bush, it</td>
<td>Axes, spade, shovels, hoe, panga (manual) and</td>
<td>About 100/N$</td>
</tr>
<tr>
<td></td>
<td>is effective in killing woody seedlings and saplings when they</td>
<td>mechanised machinery such as graders and</td>
<td></td>
</tr>
<tr>
<td></td>
<td>are still fire-tender. Recommended for use during follow-up</td>
<td>graders and tractors.</td>
<td></td>
</tr>
</tbody>
</table>

This project intends to use the mechanical bush control method with technology (see below) that enables high selectivity with limited negative impact and a reasonable harvesting rate.

Figure 5.1 below shows images of mechanical control using a front-loader to push the tree down to the soil such that it uproots.

An observed disadvantage is that there will be more dirt (soil/ash content, including microbes) remaining in the bush material due to be converted either to charcoal or into animal feed. In this case example, the bush is manually trimmed to the appropriate dimensions for chipping, while the remaining materials are reused on the site.

The images below (Figure 5.2) are of another case example using a scissor appliance mounted to a caterpillar with an extendable hydraulic arm that improves reach and selectivity. The farmer intends to have a smaller vehicle (tractor) with a mounted scissor appliance to lower cost and improve operational flexibility.

In Figure 5.3, one can observe the regrowth emerging from the stump, limiting the recovery of grazing land, according to the farmer on whose land the picture was taken. Another concern at leaving a cut stump in the ground is that it might lead to livestock injuries. Observation indicates that grazing land recovers better where bush has been controlled leaving no stumps behind.

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In 2012, the “Bush Roller” (see below Fig 5.4) was introduced when an article appeared in a local newspaper with the headline, “A cheaper solution to invader bush.” In the image below, one can picture the heavy-weighted cylindrical roller pushing down trees/vegetation. This is species-indiscriminate bush control with some bushes/trees uprooted and some not. Due to the roller weight, there is breakage and damage to branches that could even jeopardize the quality selection for charcoal, in which bush components of similar appearance and size are preferred for uniformity and a sign of quality. The bush roller is best suited to harvesting material for use as fuel, as burning chips to power industrial furnaces, or even as energy pellets by reducing wood biomass.

Figure 5.4 - Bush roller in action

5.1.2 Bush chipping

Post-harvesting, chipping is a critical point in the value chain as it enables further processing, value addition, and product development. When chipping, size selection is important for feed conversion such that particle size after drying would be suitable for milling and compressing the bush-blended material into pellets. Chippers come in different capacities, and the chipping blades are adjustable. Bush material is fed manually into the chipper, and pre-processed material can make for regular and rapid intake and chipping.

Below are examples of chippers in use in Namibia, noting that there may other different models and types not seen by the project team.

5.1.3 Drying

Air-drying on a flat clean surface in Namibia is understandable as one measure to harness free resources, namely the warm and dry prevailing climate. The current approach takes up large surface areas where bush material is laid out/scattered to enable enough exposure from air and sun. This approach could be enhanced by:

- Enclosing the area with high-density mesh netting that prevents dust and sand from coming through, but allows airflow;
- Ensuring the surface is slanted to drain water and dust-free when material is laid out/scattered, and
- Compacting and/or expediting the drying process by creating shelves exposed to hot airflow or a rotary grid dryer with forced air circulation (with an intention to divert the gas flow from charcoal production to dry bush material to feed).

In another case example, Langbeen Farm has 3 chippers, one of them currently in use (Tomcat chipper Model 2590 AFX) but unable to chip a size suitable for milling (centre image below with pen for size reference – 5-10 cm chips). A second chipping is required at additional cost and time.

Figure 5.6 - Images showing the chipping machines and chips produced at Langbeen Farm, Dordabis, northeast of Windhoek

The second and third chippers are from SchutteBuffalo. Chips are air-dried and packed in big bags (1 tonne size), which are transported to the storage location where chips air-dry on a flat concrete surface and then undergo a second chipping into the appropriate size for milling (Ø 8 mm). Air-blowing the chips is not effective as there is limited target control such that chips miss the bag opening and land on the ground, mixing with sand and stones.

Figure 5.7 - Images showing the harvested bush material, chipping machine, and chips produced at BosPro Products

A third case example is from BosPro Products, which uses a Bandit 150 Model chipper that appears to have higher production capacity than the above-mentioned equipment at Langbeen Farm. At this operation, no second round of chipping is required following the processing of twigs and branches up to approximately 20 mm Ø ready for milling. A second Bandit 1890 XP chipper with an integrated motor is on stand-by. The farmer has experience with US machinery and equipment.
5.1.4 Milling

Milling the bush material is essential to achieve a consistency that can be blended with supplements/ingredients/additives to produce animal feed. This has been proven in feeding trials. Like the above current experiences with chipping, the three case examples below provide awareness and understanding of the current milling technology and milling practices used in Namibia. In all three case examples, the "Drotsky" hammermill is used, as described below.

At UNAM’s Neudamm Agricultural Campus, there is a hammermill (see pictures below) which needs significant refurbishment. The lesson taken from the UNAM example is the critical importance of screening bush-material before milling to ensure no stones or unwanted materials enter the mill. The Neudamm mill broke due to stones.

| Figure 5.8 | Damaged Drotsky Hammermill at Neudamm Agricultural Campus |

Langbeen Farm has a hammermill on the premises where feed pellets are produced as seen below. The pelletizer delivers 8 mm pellets that animals consume with ease.

| Figure 5.9 | Pelletizing line at Langbeen Farm with a sample of the pellets (the size of the pellets is 8 mm) |

BosPro Products has a hammermill fitted with a generator that enables bag-filling as seen below. The particle size after milling is smaller than that at UNAM and Langbeen Farm, which explains the ease of mixing and pelletizing at BosPro.

| Figure 5.10 | Hammermill at BosPro Products connected to a bag-filling machine that facilitates production and packaging |

5.1.5 Mixing/Blending

Bush material is processed to a degree that enables mixing with additives/supplements/other ingredients to compose a complete or partial feed. The process of mixing/blending is important as it determines the extent to which ingredients are blended to provide a palatable recipe for animal feed. The following section describes current practices to mix/blend bush material for animal feed.

UNAM/Neudamm Campus has no mixing equipment at present. The intention is to have a complete feed production value chain.

| Figure 5.11 | Conventional or standard concrete mixer used in Namibia |

Langbeen Farm uses a conventional screw mixer, which is not optimal since it cannot fully mix small volumes of additives with bush material. This mixing leaves a variable blend of feed that is unreliable and would yield varying results. Good results have been achieved using a concrete mixer for a batch-type mixing process. Using a concrete mixer optimises the use of such machinery.

| Figure 5.12 | Concrete mixer used in Namibia |

BosPro Products uses a semi-industrial mixing process that consists of sheltered storage at ground level for the different components of the final mix and an elevated mixing platform where the supplements and additives are fed into a small open chute that includes a slowly turning agitator. From this chute, a screw conveyor feeds the pelletizer as seen in the pictures below. This setup results in a continuous pelletizing operation that can allow increases in capacity.

5.1.6 Pelletizing

Pelletizing is highly recommended as a means of delivering a product that is known in the market ("look and feel") and of extending product shelf-life. Below is a brief description of the practices currently used in Namibia.

At UNAM’s Neudamm Campus – a Johnson pelletizer including a feed silo, the conveyor to the pelletizer, and a conveyor from the pelletizer to the elevated storage and cooling bin. This pelletizing line has not yet been used.
Several feeding trials have been carried out in Namibia, especially in the study conducted in 2016 in a 12.5 kg dairy cow study. The results (e.g., weight gain) of bush-based feed were promising. BosPro Products has been in operation for over five years and has a portfolio of marketable products, some of them registered with the Department of Veterinary Services. See picture below of a bush-based animal feed recipe and marketing images on BosPro Products’ website (bush makes up 58% of the feed).

### 5.1.8 Summary of current practices and trends

- **Awareness of assessed benefits**: Market development and consumer interest can be stimulated by generating wider awareness of the assessed benefits of bush feed, i.e., proteins content, daily average weight gains, reducing pressure on underground water resources, and enabling restoration of pastures.

- **Guarantee quality and consistency of assessed benefits**: Product development is required, based on international feed production and quality standards, to ensure acceptable shelf-life and preservation of the nutritional and mineral qualities that deliver the assessed benefits. Two existing producers are adding this awareness and industry progression, which will facilitate standard-setting. The recent registration of the Langbeen Farm product is evidence of advancement in this regard.

- **Harvesting and supply of material as key factors**: As mentioned above, the cost of harvesting and transporting the raw material is a key consideration in the commercial development of bush-based animal feed. In the case of this project, the feed is the standard for the species of bush and the quality and quantity of material to be used. The project modelled a harvesting cost of N$2/100 kg, which will be tested in 2019 to ascertain viability.

- **Optimising/improving current practices and trends**: From the above, several inefficiencies and weaknesses can be observed, particularly for UNAM/NamCarn and Langbeen Farm. These are non-commercial operators with no incentive (yet) to optimise and eliminate weaknesses. In the case of BosPro, the process can be improved, and the owner mentioned some actions planned that include up-scaling production. Key observations include:
  - Ensuring limited/negligible environmental impact during harvesting and ensuring basic training and provision of protective gear and appropriate tools for harvesters;
  - Screening and pre-processing the material before chipping and milling to ensure only bush material is present (no stones);
  - Enclosing the drying areas to avoid contamination of the material and/or considering a cylindrical rotational drying method that uses air to reduce drying time;
  - Ensuring the material is dry enough before chipping and ensuring the appropriate chipping size to avoid chipping twice to achieve the desired particle size for milling;
  - Species and size selection require more attention to ensure quality, palatability, and that only target encroacher bush species are targeted;
  - Diesel consumption is reportedly high due to the use of tractor engines to power the chipper, miller, and pelletizer. It is worth considering a renewable energy option, particularly solar;
  - The above is influenced by the size and scale of production, whether at individual non-commercial/semi-commercial or at industrial scale.

### 5.2 CURRENT STATUS AND TRENDS OF CHARCOAL PRODUCTION

#### 5.2.1 Charcoal: origin, uses and characteristics

Charcoal is an important natural resource that has been used throughout history for many purposes, including art, medicine, and chemistry. However, its primary use has been as a source of wood. Although charcoal can be made from a variety of animal and vegetable products, the most common commercially available charcoal is made from wood.

It is produced by slow pyrolysis, which is heating wood or other substances in the absence of oxygen or with its presence in limited amounts. Pyrolysis, or carbonization, is initiated by heating a pile of wood under controlled conditions in a closed space such as a drum kiln or retort with a very limited supply of air, triggering endothermic and exothermic reactions. As a result of the pyrolysis process, the biomass produces a mixture of gas, liquid, and charcoal.

Charcoal produced from hardwood is heavy and strong, whereas that produced from softwood is soft and light. The transformation coefficient is about half (example: eucalyptus, with a density of about 0.6 t/m³, yields charcoal with a density of around 0.25 to 0.35 t/m³).

Charcoal has a relatively low moisture content of around 3 to 10%. The heating value of charcoal is linked to the amount of fixed carbon and heavily depends on the carbonization temperature, which can vary from 27 to 35 MJ/kg. Low carbonization temperatures yield more charcoal, but this charcoal is low grade, is corrosive due to its content of acidic tars, and does not burn with a clean smoke-free flame. Good commercial charcoal should have a fixed carbon content of about 75%.

Charcoal is produced in Namibia and has a portfolio of marketable products, some of them registered with the Department of Veterinary Services. See picture below of an animal feed recipe and marketing images on BosPro Products’ website (bush makes up 58% of the feed).

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5.2.2 Namibia Charcoal Association (NCA)

The Namibia Charcoal Association (NCA) came into operation following significant concerns and challenges that emerged in a largely unregulated and uncontrolled sector. A 2010 report by the Legal Assistance Centre (LAC), “Namibia’s Black Gold? Charcoal Production, Practices and Implications,” is noted as a catalyst that led to the emergence of the NCA.

There are currently between 6,000 and 10,000 small-scale charcoal producers in Namibia using mainly the rudimentary drum kiln, with some 20% or less considered to be Angolan nationals. Many are species non-selective, do not use any protective equipment, and do not comply with environmental safety standards.

This informal sector took off due to the low investment cost required to become operational and the easy opportunity to “off-load” unprocessed charcoal to the processing and exporting companies at an agreed price per kg.

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Bush material above Ø 20 mm is preferred, but at NCA, charcoal below this size was observed. The NCA advised that the following species be preferred for charcoal: D. cinerea, Acacia mellifera, Acacia reficiens, Terminalia prunoides, Combretum apiculatum, C. mopane. For most of these, nutritional and mineral values have been analysed, and they have shown success in feeding trials.

NCA confirmed an annual unmet export demand of 100,000 metric tonnes of charcoal. This demand increases the viability of co-product development, while Jumbo and Makara show interest as bulk buyers of any product.

5.2.3 Jumbo charcoal

The oldest commercial charcoal processor, marketer, and distributor in Namibia, it delivers about 20,000 metric tonnes (mt) of charcoal per year with most exported to the United Kingdom, while other markets are in Poland and Asia.

Jumbo employs about 250 people: 180 in the processing unit and another 70 at the warehouse and packaging facility in Walvis Bay. Sales at the Walvis Bay facility are N$1,500/tonne for non-FSC charcoal and N$1,700/tonne for FSC charcoal.

Processing includes collecting the raw charcoal from producers, quality assurance, sieving/sifting, and packaging in branded bags. For the UK market, given the prevailing overcast weather, Jumbo produces a “ready-to-burn” product with packaging laced with a flammable agent to enable lighting the entire packaging.

The company purchases from about 18 FSC kiln operators and from about 20 non-FSC kiln operators, each with a labour force of approximately 20 – 40 persons. The company has some small retort kilns that are not in operation.

5.2.4 Makarra bush products

The company delivers about 10,000 tonnes of charcoal/year, employs about 150 people, and acts as a purchaser of drum kiln-produced charcoal. Processing includes collecting the raw charcoal from producers, sieving/sifting, quality assurance, packaging, and preparation for shipment (like Jumbo’s operation).

Due to the considerable volumes of charcoal fines (≤ 5 mm particles on average) as a waste product from charcoal processing, briquets are also produced. Fines are procured from Jumbo charcoal at a price associated more with ease of access, since it is waste material that is transformed into a high-margin product.

The company uses simple drum kilns and sells drum kilns to its producers at N$2,500.

5.2.5 Traditional drum kiln versus retort system

Namibia’s pursuit of a nationalised Namibian Forestry Stewardship Council (FSC) standard and the NCA’s commitment to reforming the industry by ensuring regulation and control are great steps in the right direction. While this project focuses on delivery of an industrial-scale cleaner production mechanism, NCA is supported by other Donors as it seeks to deliver a cleaner and more efficient production technology that can be used by small-scale producers.

The table below details the differences between the currently used drum kilns and this project’s intended retort containerised system.

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\[http://www.lac.org.na/projects/lead/Charcoal.pdf\]
5.3 INTEGRATED FEED-CHARCOAL PRODUCTION SYSTEM

As mentioned above, the production system would comprise an Integrated Feed-Charcoal Production (IFCP) System that would aim to have zero waste and reuse of energy. The system would comprise a containerised feed mill and a containerised retort charcoal production system.

5.3.1 Containerised feed mill

This technology (see image below) replicates the totality of steps in animal feed development, including chipping, milling, mixing (blending) and pelleting. The maximum capacity of this technology is 2 metric tonnes (mt) per hour, capable of continuous production due to matching equipment capacities and quality settings between each of the production steps. The process and technology are calibrated such that every step in the production has 2 mt/hr capacity.

The project has the fortunate position of ordering the equipment almost custom-built for bush-based feed production. Hence, specifications of the conditions and raw material in Namibia have been shared with the specialists to facilitate design and provide a turnkey solution that meets local conditions.

The technology companies are all based in Finland, and all of them, with one exception, visited Namibia to become familiar with local conditions and the target input material. Hence, the technology complies with stringent European quality standards, which may differ from the requirements in Namibia, for example, that it be less automated to allow more employment. Given the sophistication of the technology, the investment is substantive as it translates into higher production capacity, improved quality, robustness and durability of the technology. This scale and quality of technology can be optimised and harnessed to deliver quality products beyond the Namibian border.

As depicted above, the production system is enclosed such that the quality of the feed is ensured by elimination of contamination or interference;

The milling and mixing module is separated from the pelleting module which handles a variety of input materials after milling and before mixing;

Before pelleting, the material undergoes a conditioning process with water and steam for hygienic purposes to meet EU quality standards to avoid passing on pathogens from the raw material to the animals. Since this is a standard add-on compared to local productions, it may be an option for downgrading, a decision that would decrease investment and operating costs;

The pelleting module, as depicted above, comprises three small containers overhead to leverage the use of gravity for internal transportation;

The system does not include a drying mechanism. The project intends to relay the heat/flue gases generated by charcoal production (see heating unit in pictures below) for use to dry bush chips to achieve optimal moisture. The intention is to harvest bush material during the rainy season for which current data on moisture content are not available. The available data are for bush material sampled outside the rainy season, with moisture levels around 10% or higher.

The flowsheet below describes the aforementioned four-stage processes (dosing – milling – mixing – pelleting) in more detail:

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The flowsheet below describes the aforementioned four-stage processes (dosing – milling – mixing – pelleting) in more detail:
5.3.2 Containerised retort system

The retort is one of the most efficient small-scale industrial units for producing good quality charcoal. In this pyrolysis process, charcoal is produced under highly-controlled, nearly oxygen-free conditions, delivering significantly improved product quality at a higher yield compared to total input material, and in an environmentally safer way. This process – common to the retort process – returns the wood gases from the carbonization chamber back to the external firebox, burns the volatile components almost completely, and uses the heat for the carbonization process, e.g., by burning the generated methane (CH₄).

In case no grid is available, a solution with a generator will be engineered and will represent an option, also at additional cost. Overall electricity consumption for milling, mixing, and pelleting for a 2 tonnes/hour plant will be approximately 90–120 kWh/hr in full operation; slightly overheated steam demand will be 150 kg/hour; water consumption will be limited and is approximately 500 l/hour.

When making cost evaluations based on current production, it needs to be considered that operational cost disadvantages of the new plant compared with existing productions may be detected. However, these will not be based chiefly on complete cost accounting of existing productions, since the “critical size and industrial approach” followed within the current Project case has clear cost advantages.

The erection and installation of the plant and its supplementary equipment may be provided locally. A company supervisor will survey installation and start-up, including commissioning of the plant.

5.3.3 High-margin charcoal products

The global market for charcoal includes all kinds and varieties of charcoal as there are multiple uses across the globe, ranging from heating to cultural and religious applications to aesthetic, therapeutic, and nature conservation uses. Below are brief descriptions of high-margin products that leverage charcoal’s specific property of a large internal surface area.

- **Biochar**
  - Produced by pyrolysis process at temperatures above 300 °C.
  - Puts to use the ability to retain nutrients, impurities, and water.
  - Main applications:
    - Soil enrichment and improvement;
    - Increasing carbon retention and nutrient recycling, and enabling water filtration, used in compost and sewage treatment;
    - The broad spectrum of water filtration, sooty and compact treatment; and livestock conditioning and health enhancement.

- **Chemically-activated charcoal**
  - Wood-based activated charcoal is commercially made using temperatures between 450–900 °C and phosphoric acid.
  - “Activation” increases the internal surface area on the order of 600 to 1,200 m²/g, depending on the raw materials and process used. At maximum, one gram of activated carbon has a surface area in excess of 1,000 m².
  - Wood will be first pyrolyzed; then the char is saturated with phosphoric acid, followed by controlled reheating to enhance the chemical erosion of carbon atoms, followed by an elaborate washing cycle to remove the acid.
  - Main applications:
    - Air and water filtration;
    - Applications in the chemical, nuclear power, medical and food industries.

- **White charcoal**
  - It is made by carbonizing wood at moderate to low temperatures, and towards the end, raising temperatures to about 1,000 °C to generate a red charcoal, which requires an extra oven;
  - It requires skill to remove the deep red charcoal from the kiln and quickly smooth it with a powder cover to cool it. The powder is a mixture of sand, earth, and ash which gives a white colour;
  - White charcoal ignites slowly but has high thermal conductivity (compared to regular charcoal);
  - Main applications:
    - Water filtration;
    - Chemical absorption;
    - Medical applications; and
    - Absorption of electromagnetic waves.

5.3.4 Industrial approach: Project implementation

The principle for an industrial approach is to have a centralized animal feed processing unit surrounded by enough closely situated bush to provide 5,000 tonnes of appropriate species-related dry animal feed chips per year. This capacity would comply with the suggested animal feed capacity of 2–2.5 tonnes/hour. The decisive advantage – finally effective regarding cost and margins – is the “economy of scale” which is the pre-condition for high-level professionalization regarding all enterprise processes with more effective equipment, high capacity usage, and strong marketing and management capabilities.

Following the “industrial approach,” there are basically two implementation options in place, which may be combined depending on the availability of appropriate management and/or business-related structures.
STRATEGIC ACTION PLAN FOR SUSTAINABLE BUSH VALUE CHAINS IN NAMIBIA

5.4 TECHNOLOGY APPROPRIATENESS AND SUSTAINABILITY

This project assessed the viability of an industrial-scale approach to converting encroacher bush to animal feed and charcoal. This scale of approach is proposed as it would enable delivering the “triple-wins” mentioned before: significant encroacher bush reduction, unlocking potential for rangelands restoration, and generation of employment.

5.4.1 Functional appropriateness

Both the animal feed production mill and the containerised retort system are functionally appropriate as they can deliver the desired product at superior quality and can produce the high volumes associated with industrial scale operations.

5.4.2 Durability, serviceability and parts replacement

Since the density of Acacia trees exceeds 0.67 t/m³ and Acacias are known globally for their exceptional hardness, the durability of the technology was in question. Following the visits by the companies and after testing bush material taken back with them to Finland, the Finnish companies deemed that the technology is durable in this application.

5.4.3 Affordability and replacement cost

Based on the financial viability analysis which looks at profitability after all expenses, taxes, and other obligations, the technology is deemed affordable with a return on investment achievable in year 5 of the business.

5.4.4 Replicability, assembly or local manufacturing

Despite the fact that the suggested technological processes (production of bush-based animal feed and production of retort charcoal) have not yet been introduced or practised in Namibia, the future opportunities should exist to build significant parts of all three plants in Namibia. Relevant discussions have been held with the Finnish technology providers, who are prepared to provide the necessary know-how as part of a customized technology transfer programme. This may lead within a reasonable time to manufacturing cooperation between Finnish and appropriate Namibian companies, which may have a strong impact on the realization of the earlier mentioned “multiplier effect,” since demand for both products will not nearly be met by the suggested new plants. The resulting benefit will be the transfer of technology and know-how together with the creation of employment in the Namibian manufacturing industry.

5.4.5 Impact of this technology

The European Union applies very stringent directives and regulations for the development of technology. Such directives and regulations consider all possible social, economic, and environmental impacts and try to address these during the planning, design, and prototype phases.

5.4.6 Research and Development

This “industrial pilot plant” is intended to address in a resilient and sustainable manner the production opportunities for a type of animal feed that can solve livestock, drought, and other problems. The plant’s role as an “industrial pilot plant” also makes it important to have the participation of an R&D institution, e.g., UNAM, to accompany the execution of the project with the analytical and economic research needed to finally achieve an optimal solution for plant use and operation. Consequently, this plant’s status as an “industrial pilot plant” requires a more sophisticated plant configuration, so that commercial plants, which will be developed at a later stage, can take advantage of the opportunity presented by the high demand of the market.

In addition to the above processes, a R&D implementation process will have to accompany both options to assure the technological development of the products.

These 2 implementation options determine the range of given business approaches for phase 2 of this project, out of which the most appropriate option – option 1 or 2 or an intermediate solution – will be developed. This requires Namibia-internal discussion and decision, which may also be related to funding considerations. However, if the project is implemented and equipment is to be procured, an addressee for the procured equipment will be required.

From the Plant Supplier Perspective

According to basic market figures and the “multiplier factor” described, the opportunity exists to multiply this application by setting up operations in several locations. This will require plant suppliers to consider a series of effects on design and equipment delivery costs.

Project Implementation

Before orders for plant equipment are approved, a clear and approved marketing and sales concept with well-defined products aimed at the

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Institutional and Legislative Overview

6.1 NATIONAL STRATEGY TO UNLOCK ECONOMIC BENEFITS  64
6.2 FORESTRY AND ENVIRONMENTAL AUTHORISATION PROCESS FOR BUSH HARVESTING PROJECTS  64
6.3 FORESTRY PERMITS  64
6.4 INSTITUTIONAL OVERVIEW  64
6.1 NATIONAL STRATEGY TO UNLOCK ECONOMIC BENEFITS

The 2018 draft "National Strategy for the Optimization of Rangeland Management and Encroacher Bush Utilization" and its implementation plan seek to scale up efforts to control encroacher bush and use biomass to produce value-added or beneficial end-products. The strategy is a joint effort by MAWF and MITSMED, supported by other line ministries, development partners, the private sector, and civil society. The strategy has a five-year timeframe to achieve the following Strategic Objectives and Outcomes.

<table>
<thead>
<tr>
<th>STRATEGIC OBJECTIVE</th>
<th>INCREASE ACCESS TO THE PRIMARY RESOURCE</th>
<th>MARKET DEVELOPMENT</th>
<th>RESEARCH AND DEVELOPMENT</th>
<th>FINANCIAL INCENTIVES TO STIMULATE ECONOMIC ACTIVITIES</th>
<th>PRODUCTS FOR BUSH HARVESTING AND VALUE-ADDED PRODUCTS</th>
<th>STRATEGIC OUTCOME</th>
<th>SECURITY OF THE BIOMASS AVAILABILITY</th>
<th>LOCAL AND INTERNATIONAL MARKETS FOR ENCROACHER-BUSH-BASED PRODUCTS EXPANDED</th>
<th>EFFECTIVE FINANCIAL INCENTIVES IN PLACE</th>
<th>IMPROVED CAPACITY FOR IMPLEMENTATION</th>
<th>IMPROVED RESULTS OF THE NATIONAL STRATEGY</th>
</tr>
</thead>
</table>

6.2 FORESTRY AND ENVIRONMENTAL AUTHORISATION PROCESS FOR BUSH HARVESTING PROJECTS

This very instructive 33-page book provides information and guidance on the background to bush encroachment, the species, the actors, and the policy and legislative environments that allow or pose potential barriers to the harvesting and/or utilisation of encroacher bush. Most of the content is addressed throughout this Strategic Action Programme, but for a more focused review, the reader is advised to obtain a copy. See the sections below on permits and the need for environmental clearance when harvesting more than 5,000 hectares of bush. In closing, the booklet contains some valuable and resourceful contact details to follow up on specific matters or to obtain more information about the emerging bush biomass sub-sector.

6.3 FORESTRY PERMITS

All harvesting of trees and woodland in Namibia is governed by the Forest Act of 2001 and its regulations of 2015. This Act is administered by the Directorate of Forestry in the Ministry of Agriculture, Water, and Forestry.

- Harvesting Permit
  - Required for any tree cutting and/or harvesting of wood for commercial purposes.
  - Issued by the Licensed Officer, it stipulates conditions for harvesting.
  - Inspection of an area to be harvested must be performed before the permit is issued and when an application for renewal is made every 3 months.
  - Cost for commercial purposes is N$250, for communal purposes, it is N$250 and is valid for 7 days; and for personal use, it is N$10 and is valid for 3 days.

- Export Permit
  - Required to send any wood or wood products outside Namibia.
  - Obtainable from any Forestry Office, it is valid for 7 days for commercial value-added products costing N$15 per tonne, up to 10 tonnes; and an additional fee of N$1 per tonne is imposed beyond 10 tonnes.

- Transport Permit
  - Required to convey any wood or wood products (e.g., logs, planks, charcoal, and firewood).
  - It is obtainable from any Forestry Office and is valid for 7 days at a cost of N$250 for commercial purposes and 3 days for personal use at a cost of N$50.

- Marketing Permit
  - Required to enable the producer to sell her/his products to any other party.
  - The permit is valid for 3 months in commercial areas at a cost of N$500, while in communal areas, the permit is valid for 1 month only.

6.4 INSTITUTIONAL OVERVIEW

The operation of the plant and the distribution of products has to comply with the national legislation and regulations, which are duly considered as part of this document. The following legal acts of Namibia with their relevant conditions are to be considered for the operation of the animal feed and charcoal production.

<table>
<thead>
<tr>
<th>INSTITUTION</th>
<th>ROLE IN REGULATING ENVIRONMENTAL PROTECTION</th>
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<tbody>
<tr>
<td>Ministry of Environment and Tourism (MET)</td>
<td>The MET is the lead government agency charged with Environmental Monitoring, Assessment and Management. The mission of the MET is to maintain and rehabilitate essential ecological processes and life-supporting systems, to conserve biodiversity, and to ensure that the utilization of natural resources is sustainable for the benefit of all Namibians, both present and future, as well as the international community, as provided for in the Constitution. The MET plays a role in the development of Environmental Impact Assessment (EIA) which is a tool used pursuant to the Environmental Management Act for Sustainable Development and Environmental Conservation (1995). Provisions in other key ministerial legislation strengthen MET’s position.</td>
</tr>
<tr>
<td>Ministry of Agriculture, Water, and Forestry (MAWF)</td>
<td>The MAWF is the leading agency moving the Agricultural, Water, and Forestry sectors towards the promotion of the efficient and sustainable socio-economic development of Namibia. MAWF is the regulating body of the promotion of the Water Resource Management Act, 2004 and the Forest Act 12 of 2001, relevant to this project. The Department of Water Affairs is the government agency responsible for monitoring and reporting water quality.</td>
</tr>
</tbody>
</table>

6.5 LAW

The Constitution of the Republic of Namibia, 1990

The Constitution is the supreme law in Namibia, providing for the establishment of the main organs of state (the Executive, the Legislature, and the Judiciary) as well as guaranteeing fundamental human rights and freedoms. Provisions relating to the environment are contained in Chapter 11, Article 93, which is entitled “Protection of the Welfare of the People.”

The Environmental Management Act (EMA) No. 7 of 2007

As a guiding principle for environmental management, this Act gives effect to Articles 91(1) and 91(5) of the Namibian Constitution by establishing general principles for the management of the environment and natural resources, by promoting the co-ordinated and integrated management of the environment, by giving statutory effect to Namibia’s Environmental Assessment Policy, by enabling the Minister of Environment and Tourism to give effect to Namibia’s obligations under international conventions. Part V of the EMA lists different activities that are subject to the EMA. Sections 27(3) and 35(1) state that unless a project developer has an environmental clearance certificate granted by the Environmental Officer after assessing the scope, procedure, and methods for conducting the assessment, the developer may not undertake the listed activity.

The Public Health Act 36 of 1919

This is the primary law that governs and oversees the management, development, preservation, and water, and of water resources. Part VIII of this Act makes provisions for the abstraction and use of water, such that a licence is required for such an activity. Further procedures in this process are mentioned in section 33. The protection and control of groundwater areas are mentioned in part XXI of this Act to ensure to engage in drilling, construction, and enrichment or alteration of a borehole. Water pollution control is set out in part XXVI, whereby discharge of effluents or construction of a treatment facility or disposal site requires a permit. Terms and conditions for such a permit are set out in section 61.

The Soil Conservation Act 76 of 1969

Objectives of the Soil Conservation Act 76, 1969 are to make provision for the combating and prevention of soil erosion, and for the conservation, improvement, and rehabilitation of soil and its productive capacity. The Soil Conservation Act 76, 1969 is applicable to the whole of the Republic of Namibia.

The Labour Act of 1992

The Labour Act gives effect to the constitutional commitment of Article 71(1), to promote and maintain the welfare of the people. This Act is aimed at establishing a comprehensive labour law for all employees, to promote fundamental labour rights and protections; to regulate basic terms and conditions of employment; to ensure the health, safety, and welfare of employees under which provisions are made in chapter 4. Chapter 5 of the Act imposes on the employer of employees from unfair labour practice.

The Pollution Control and Waste Management Bill

The purpose of this Bill is to regulate and prevent discharge of pollutants to the air, water, and land in Namibia, and to enable the country to fulfill its international obligations in the regard. The draft Bill forbids any person from discharging or disposing of pollutants into any water or water course without a water pollution licence (except from the discharge of domestic waste from a private dwelling or the discharge of pollutants to waste to a sewer or sewage treatment works).

The Environmental Protection Ordinance of 1976

According to section 31(1) of this Act, a developer is not allowed to cut down or remove any indigenous trees from any property without a permit. The Development of Forestry listed all the Namibian protected tree species according to the Forestry Ordinance of 1952.
## 7 Impacts and Risks

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.1 KEY ENVIRONMENTAL CONSIDERATIONS OF BUSH ENCROACHMENT</td>
<td>68</td>
</tr>
<tr>
<td>7.2 ENVIRONMENTAL ISSUES CONCERNING ANIMAL FEED</td>
<td>69</td>
</tr>
<tr>
<td>7.3 ENVIRONMENTAL ISSUES CONCERNING CHARCOAL</td>
<td>70</td>
</tr>
<tr>
<td>7.4 KEY SOCIAL CONSEQUENCES OF BUSH ENCROACHMENT</td>
<td>71</td>
</tr>
<tr>
<td>7.5 FOLLOW-UP MEASURES</td>
<td>71</td>
</tr>
<tr>
<td>7.5.1 Follow-up measures methods</td>
<td>71</td>
</tr>
<tr>
<td>7.5.2 What comes after follow-up measures?</td>
<td>71</td>
</tr>
<tr>
<td>7.5.3 Rangeland Management Policy and Strategy</td>
<td>72</td>
</tr>
<tr>
<td>7.6 RISK ANALYSIS AND MANAGEMENT</td>
<td>72</td>
</tr>
</tbody>
</table>
7.1 KEY ENVIRONMENTAL CONSIDERATIONS OF BUSH ENCROACHMENT

A savanna ecosystem is complex, with strong inter-dependence among trees, grasses, and soil. Within a defined area, the impacts of bush encroachment would be visible through spatial dominance of encroacher bush, reduction in biodiversity, and possibly habitat rearrangement. When a system is in balance while encroacher species are present, the following processes take place. Trees, including leguminous trees such as Acacias, draw minerals from below ground (soil organisms responsible for decomposition and nutrient recycling), in the case of grassland, to above-ground production. The leaves and twigs are soft and higher in moisture and protein content (up to 16%); harvesting is done selectively to access encroacher species to thrive or not, depending on their adaptability, thereby altering the grass-dominated ground cover. Shade-adapted shrubs start to colonize this area, creating the ideal habitat for other tree species to establish themselves. This process results in a transition from herbaceous species, i.e., a decline in grass abundance and density, to woody and sometimes invasive species. This transition in vegetation alters the overall biomass of the savanna from below ground (soil organisms responsible for decomposition and nutrient recycling), in the case of grassland, to above-ground production. The leaves and twigs are soft and higher in moisture and protein content (up to 16%). Harvesting is done selectively to access encroacher species that have proven successful as bush-based feed. Importantly, the SEA acknowledges the sustainable development potential that bush value chains are destruction and disrupted, and along with the ecological roles and processes they support. While some resilient species may adapt and survive, other animal biodiversity and associated processes with lower resilience and adaptability will not be able to adapt. The agriculture and tourism sectors are among the top five employers and GDP contributors and are referenced in the sectoral benefits in mind, such as:

- Selective harvesting, instead of mass land clearing, enables the selective harvesting of biomass and reduces soil quality issues.
- Harvesting is done selectively to access encroacher species that have proven successful as bush-based feed. Mainly Acacia melanoxylon is used, while [NAFOLA project] nutritional and mineral content information is available for four additional encroacher species.
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7.3 ENVIRONMENTAL ISSUES CONCERNING CHARCOAL

Charcoal has been produced in Namibia since the 1980s by Jumbo Charcoal, 3 km west of Okahandja. Since 2005 to 2010 the sector has seen significant growth, a continuing trend resulting in between 6,000 and 10,000 small-scale charcoal producers (SSCPs) operating in both communal and commercial farming areas. These producers comprise 5-15 persons per operation and sell charcoal per tonne to commercial processors and exporters, such as Jumbo Charcoal. The low cost of making or buying a rudimentary kiln eases entry into production, while the extent of bush encroachment suggests economic viability from a biomass stock availability point of view. The significant growth observed from 2001-2010 was also as a response to addressing bush encroachment through an economically viable approach. Hence, commercial farmers allow SSCPcs on their land to produce charcoal in areas where they require thinning of encroacher bush. The labour-intensive nature of the industry is attractive to impoverished and unskilled persons, and for the rural poor, it has become an affordable and relatively easy way to mobilise means of self-employment and income generation. The cost of the kilns used by the labourers is low, and it is paid on a commission basis. The removal of bush and associated minerals and nutrients from the land is considered an activity for which there is no standard assessment procedure or monitoring of negative impacts resulting from charcoal production on health and to allow early detection of potential negative legacy issues.

While the report does not go into detail about the environmental impacts, it references common impacts associated with bush thinning activities and negative impacts resulting from charcoal production.

7.4 KEY SOCIAL CONSEQUENCES OF BUSH ENCROACHMENT

Bush encroachment is recognised as a formidable sustainable development challenge, socially, economically and environmentally. In order to explore the potential viable opportunities to address these challenges and propose solutions for bush control and utilisation of biomass that could catalyse enhanced agricultural productivity, these challenges are to be identified, as outlined below.

- With a total number of dependents on these farms projected at approximately 140,000 people (average household size of 4.03), who are or would be affected by the bush encroachment problem.
- Lower farming capacity results in reduced ability to secure food and thus lowers the resilience of farmers who already face a myriad of external factors such as price fluctuations, climate variability and diseases.

7.5 FOLLOW-UP MEASURES

Two objectives of follow-up measures include:

- Rehabilitation and ensuring rangeland productivity, and
- Preventing re-encroachment.

7.5.1 Follow-up measures methods

Follow-up measures entail, in all cases, the systematic removal of small, immature woody plants (mainly low copice growth and saplings) to achieve a specific objective, e.g. to restore rangelands or to enable growth of some woody plants for use in other value chains. In the interest of the environment, it is advised to practice selective follow-up measures with non-chemical methods. Follow-up measures can range from highly selective methods with specific objectives to non-selective methods with no clear objective for post-thinning land use.

HUMAN HEALTH: The usual pre-employment medical examination costs N$190, while the annual or periodic medical examination costs N$170. Government Gazette No. 40/17 of 15 May 2010 reduced these costs to N$15 and N$8, respectively, for self-employed state patients, including people involved in the charcoal industry. The Occupational medical examination for self-employed state patients, including people involved in the charcoal industry, is as follows:

1. Basic health examination: N$15. This reduction would obviously not be valid where an employee-employer relationship is entered as described by the Labour Act, since charcoal workers would no longer be regarded as self-employed.

7.5.2 What comes after follow-up measures?

Bush encroachment is promoted by inappropriate land uses, non-adaptive grazing, and unsustainable rangeland management. Hence, to adequately address its cause and prevent the recurrence of bush encroachment, land use and management approaches should shift towards sustainable practices.
7.5.3 Rangeland Management Policy and Strategy

Namibia’s National Rangeland Management Policy and Strategy (2002) is a farmer-driven policy that promotes the voluntary adoption of “principles of sound rangeland management” instead of prescriptive rules and regulations. These principles recognise that ecosystem health is at the core of rangeland management.

The policy advocates sustainable rangeland utilisation, which includes the avoidance and mitigation of man-made impacts such as bush encroachment. While bush encroachment will continue due to natural drivers, it will be much less pervasive and probably more manageable. The eight principles of sustainable rangeland management are listed below.

1. **KNOW THE RESOURCE BASE:** Know the dominating perennial species of grass and ensure optimal growing conditions. Know the soil, nutrient hotspots, and general rangeland ecology, know recurring bush encroachment until they have set seed before being grazed again.

2. **MANAGE GRASSES FOR EFFECTIVE RECOVERY AND REST:** Perennial and preferred species of grass are usually grazed first and most intensively. They need to recover completely from previous grazing until they have set seed before being grazed again.

3. **MANAGE FOR EFFECTIVE UTILISATION OF GRASSES AND SHRUBS:** Grazing should stimulate grass production and not inhibit it. Grazing domestic livestock such as cattle and sheep is cheaper because they browse without much damage. The browsing component of a savanna rangeland is under-utilised, while the herbaceous (grassy) component usually is over-utilised. Browse-based livestock enterprises are encouraged.

4. **ENHANCE SOIL CONDITION:** For grasses to flourish, the top layer of soil must be in good condition, allowing rainwater to infiltrate easily (proper water cycle) and binding plant nutrients so they do not leach out (proper mineral cycle). This condition is achieved mainly by keeping the soil well covered with living plants or mulched with dead plant litter to prevent soil erosion by wind or water.

5. **CONTROL BUSH ENCROACHMENT:** As per the MAWF/GIZ Bush Harvesting Manual.

6. **PLAN FOR DROUGHTS:** By timely reduction of the livestock stocking rate in synchrony with the advancing fodder deficit. Gone more fodder to be used during a drought.

7. **MONITOR THE RESOURCE BASE:** By keeping a variety of records of the veld that inform rangeland management. The establishment of woody seedlings is an important indicator of the transition to a bushy state, requiring management intervention.

8. **PLAN LAND USE INFRASTRUCTURE:** To make sustainable rangeland management easier, e.g., by providing enough camps per herd of livestock to facilitate effective rotational grazing management that allows perennial indicator grasses to recover from grazing.

7.6 RISK ANALYSIS AND MANAGEMENT

The following risk areas and/or factors have been identified for pilot integrated production plant:

- Slow and poor market adoption by consumers and retailers may not make it possible to reach optimal sales targets and revenues.
- The policy environment is not ready for the approval and registration of animal feeds with more than 50% concentration of bush material.
- The costs of imported feed additives and preservatives play a major role in driving production costs and thus retail pricing.
- Fluctuations in the cost of obtaining bush biomass as key raw material may negatively impact the total cost of production and thus the retail price.

Considering these risk factors, the following mitigation measures will be put in place not only to safeguard the provided investment, but also the business itself:

- There is evidence that Namibian farmers have been using encroacher bush as a feed supplement and as feed since 1972. The feeding trials that were conducted from 2015-2017 show great potential and suggest market adoption when the product is well-marketed and branded with an affordable price tag. The first 12 months will enable testing the market by conducting trial sales of the feed at consumer and wholesale levels.
- The emergence of bush biomass as an agricultural sub-sector that holds massive potential for Namibia has prompted the Directorate of Forestry, the MAWF, and line ministries to consider amending the existing policy framework to enable the development of the sub-sector.
- Feed additives such as lucerne, wheat bran, and molasses are mainly imported, even though lucerne and wheat are cultivated in Namibia. A survey is currently underway to ascertain the type and volumes of such raw materials in Namibia, and if not found domestically, to identify the most secure and sustainable regional supply partner.
- The Namibia Biomass Industry Group (N-BiG) can harvest and deliver bush biomass to the operation. N-BiG can provide bush material at an agreed price per year. The pilot plant will ensure that the price negotiated with N-BiG enables the operation to produce a final product below the upper cost limit of N$2,568 per tonne.

**RISK AREA/FACTOR**

- Slow and poor market adoption by consumers and retailers
- Fluctuations in the cost of obtaining bush biomass as key raw material
- Costs of imported feed additives and preservatives

**MITIGATION MEASURES**

- Products well-marketed and branded with an affordable price tag
- Amendment of the existing policy framework to enable the development of the sub-sector
- Ascertain the raw materials available in Namibia, or identify the most appropriate regional supply partner
- Production of a final product below an upper cost limit
### Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.1</td>
<td>SUMMARY OF KEY METRICS</td>
<td>76</td>
</tr>
<tr>
<td>8.2</td>
<td>FINANCIAL OVERVIEW AND HEADLINE PROJECTIONS</td>
<td>76</td>
</tr>
<tr>
<td>8.3</td>
<td>MARKET OVERVIEW OF THE ANIMAL FEED PRODUCTION</td>
<td>77</td>
</tr>
<tr>
<td>8.3.1</td>
<td>Global market overview</td>
<td>77</td>
</tr>
<tr>
<td>8.3.2</td>
<td>Regional market overview</td>
<td>78</td>
</tr>
<tr>
<td>8.4</td>
<td>COMPETITOR ANALYSIS AND ECONOMIC IMPACT</td>
<td>79</td>
</tr>
<tr>
<td>8.4.1</td>
<td>Namib Mills Investment Group</td>
<td>79</td>
</tr>
<tr>
<td>8.4.2</td>
<td>Other Bush-to-Feed production in Namibia</td>
<td>80</td>
</tr>
<tr>
<td>8.4.3</td>
<td>Feed prices in Namibia</td>
<td>80</td>
</tr>
<tr>
<td>8.4.4</td>
<td>Shifting Namibia’s trade balance</td>
<td>80</td>
</tr>
<tr>
<td>8.5</td>
<td>GLOBAL AND REGIONAL MARKET OVERVIEW: CHARCOAL</td>
<td>81</td>
</tr>
<tr>
<td>8.5.1</td>
<td>Top charcoal exporting and importing countries</td>
<td>81</td>
</tr>
<tr>
<td>8.5.2</td>
<td>Charcoal production in Namibia</td>
<td>81</td>
</tr>
<tr>
<td>8.5.3</td>
<td>Current and potential capacities as incentive for improvement</td>
<td>81</td>
</tr>
<tr>
<td>8.5.4</td>
<td>Structure of charcoal business in Namibia</td>
<td>82</td>
</tr>
<tr>
<td>8.5.5</td>
<td>Current drum kiln operations as reason for suggested improvement</td>
<td>82</td>
</tr>
<tr>
<td>8.5.6</td>
<td>Investigations and opportunities</td>
<td>83</td>
</tr>
</tbody>
</table>
### 8.1 SUMMARY OF KEY METRICS

The below table demonstrates the required investment cost for the demonstration and development phases of an integrated feed/charcoal production facility.

#### CHARCOAL PRODUCTION
Applying a retort system:
- Produces 30-40% higher yield than conventional system;
- Uses containerized system with lower emissions and improved environmental and human health and safety;
- Produces tar and distillates as by-products.

<table>
<thead>
<tr>
<th>Cost per metric tonne (N$)</th>
<th>4,137</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target selling price per tonne (N$)</td>
<td>7,000</td>
</tr>
<tr>
<td>Margin - selling price less cost of production (N$)</td>
<td>2,863</td>
</tr>
</tbody>
</table>

#### ANIMAL FEED PRODUCTION
Applying a modular feed mill system:
- Uses containerized system that would harness heat from the charcoal plant to dry the wood chips;
- Able to produce 2.5 tonnes of feed per hour.

<table>
<thead>
<tr>
<th>Cost per tonne of bush feed (N$)</th>
<th>1,768.25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suggested profit margin against retail price of N$4,000/t</td>
<td>56%</td>
</tr>
<tr>
<td>Cost per tonne of commercial feed (N$)</td>
<td>4,291.65</td>
</tr>
<tr>
<td>Suggested profit margin</td>
<td>14%</td>
</tr>
</tbody>
</table>

### 8.2 FINANCIAL OVERVIEW AND HEADLINE PROJECTIONS

The below table shows the estimated annual operating costs for the production facility. These are at the lower end of the market and would serve to ensure capacity during demonstration and would be adjusted during commercial up-scaling.

<table>
<thead>
<tr>
<th>Summary</th>
<th>Euro/mt ('000)</th>
<th>NAD/mt ('000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total annual revenue</td>
<td>41,560</td>
<td>4,646,000</td>
</tr>
<tr>
<td>Total annual production cost</td>
<td>25,586</td>
<td>266,562</td>
</tr>
<tr>
<td>Total gross profit</td>
<td>17,974</td>
<td>173,438</td>
</tr>
<tr>
<td>Total discounted profits (50%)</td>
<td>8,987</td>
<td>133,281</td>
</tr>
</tbody>
</table>

### 8.3 MARKET OVERVIEW OF THE ANIMAL FEED PRODUCTION

#### 8.3.1 Global market overview

In 2016 and 2017, global feed production was more than 1 billion tonnes. In 2016 this production milestone was recorded for the first time. Alltech is an American company founded in the 1970s with operations in animal feed, meat, brewing, and distilling. Since Alltech started the Global Feed Survey seven years ago, the feed industry has seen increases in production of 16.1 million tonnes per year (or 2.95% per year), a growth of 19% over the seven-year period. The USA and China deliver 35% of total feed production, while globally there is a growing trend of reducing the number of feed mills by consolidating facilities to reduce production costs and increase efficiency. This trend is evidenced by a 7% reduction in the number of feed mills, while production increased by 3.7%.
Feed production is closely related to the production of inputs such as maize, wheat, and soybeans. Global production for these major inputs has increased significantly over the past few years, largely driven by increasing demand from both food and animal feed industries.

The International Grains Council (IGC) forecasted 2017/18 global maize usage in the animal feed industry at 613 million tonnes, up by 2% from the previous season and the highest level in more than a decade.

The growth in feed production in Africa is parallel to growth in the production of primary inputs, such as maize, wheat, and soybeans. For the 2017/18 financial year, maize usage in animal feed industries was estimated at an all-time high of 32 million tonnes,26 up by 6% from the previous season. This is widespread across the region, with an increase of maize usage in animal feed up by 6% in North Africa from the previous season (estimated 14 million tonnes) while in Sub-Saharan Africa, maize usage in animal feed production increased by 3% (estimated 14 million tonnes) compared to the previous season.

### 8.4 Competitor Analysis and Economic Impact

#### 8.4.1 Namib Mills Investment Group

The Namib Mills Investment Group (Pty) Ltd established Feedmaster in 1983, which has become the leading animal feed manufacturer in Namibia, delivering annual volumes in excess of 115,000 tonnes. Initially the purpose was to convert milling by-products (initially only maize chop) into animal feed, and today, it provides a range of scientifically formulated animal feed products developed especially for domestic conditions. The feed plant has been compliant with ISO 9000 and ISO 22000 since 2007. It markets approximately 25% of its ruminant feeds to farmers in communal areas with the balance served as competitor to the proposed pilot integrated production plant. Some 5-7 wholesalers and retailers sell the Feedmaster brand along with imported products from South Africa and elsewhere.

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- The ruminant sector served by Feedmaster includes dairy, beef, small stock (sheep and goat), and animal wildlife (game). The company also manufactures feed for chicken broilers, commercial layers, and pigs;
- Feedmaster delivers 500 tonnes of feed per day, and from 2017 onward aimed at producing 140,000 tonnes per year with concomitant estimated revenue of N$800 million;
- Regarding cattle feed, additives, and supplements, Feedmaster offers 6 categories for cows and calves with the “Dry season” category offering 8 different products, mostly licks, concentrates, and supplements. The numbers of products in other categories range between 3 and 6, with the total number of products for cattle at 35, again mainly supplements, licks, and concentrates.

Feedmaster is the only animal feed producer in Namibia that would serve as competitor to the proposed pilot integrated production plant. Some 5-7 wholesalers and retailers sell the Feedmaster brand along with imported products from South Africa and elsewhere.

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8.4.2 Other Bush-to-Feed production in Namibia

Since 1997, farmers in Namibia have been converting bush biomass to animal fodder, particularly to supplement feed during droughts and the winter season. There is currently one commercial producer of animal feed, BioProProducts (Pty) Ltd, which delivers a feed that comprises 65% encroacher bush material while other ingredients include lucerne (6%), mealies (20%), a commercial feed additive to enhance taste (3%), and a growth enhancer (4%). Based in the Outjo farming area, BioProProducts serves mainly northern farmers. The owner of the operation is also aware of the demand in central and southern Namibian feed, based on weekly calls by clients who wish to buy the feed. Based on feeding trials, BioPro products can produce a daily weight gain of 1.33 kg (see figure below).

A second entrepreneur based out of the Dordabis farming community has been experimenting with bush-to-feed for nearly 5 years and has produced a feed comprising up to 85% encroacher bush. This farmer has conducted feeding trials with his own cattle and observed a daily weight gain of up to 2.1 kg, with the lowest daily gains at 1.2 kg and an average of around 1.5 kg.

UNAM, in partnership with the NAFOLA/UNDP project, supported communal farmers in Okondjato in the Omaheke region to test the development of a bush-based feed as an affordable option to raise cattle to market size. UNAM conducted feeding trials to test the feed with the participation of local farmers. Similarly to the Dordabis observation, UNAM recorded weight gains of more than 1 kg per day and found the nutritional and mineral values of the bush-based feed to be of superior quality compared to some commercial feeds. The University analysed the nutritional and mineral values of several encroacher bush species in an attempt to convince farmers and officials that encroacher bush can be intensively targeted for the conversion to bush-based feed.

In general, cattle gain between 500-700 grams of weight per day on average on natural fodder and from commercial feeds in the market. Hence, gains of more than 1 kg per day are impressive and may suggest that bush-based feed could be positioned in the domestic, regional, and global feed markets as an affordable premium feed.

To eliminate challenges posed by tannins and lignin (indigestible and unappetising components of bush material), UNAM and Seinäjoki University of Finland recommended using only bush biomass less than 20mm in diameter and harvesting encroacher bush during the rainy season to capitalise on the thinner twigs and leaves that are highest in nutritional value.

8.4.3 Feed prices in Namibia

Feed prices for livestock range between N$220 to 250 per 50 kg and N$340 to 500 per tonne.

Bush-based animal feed can be competitive in the market since it costs N$7.68 to 25 to produce a tonne of feed. The key drivers of this production cost are the costs of harvesting and transporting raw material. Hence, with the most expensive harvesting method, the production cost increases to N$7,568 per tonne, which would still make it possible to set a competitive and market-relevant price per 50 kg and per tonne.

Assuming the upper cost of production, the feed could come into the market as the most affordable at a price below N$220 per 50 kg or below N$4,400 per tonne, fetching a margin above 30%.

8.4.4 Shifting Namibia's trade balance

Based on the NSA’s 2017 Trade Reports, Namibia still suffers a negative trade balance of some N$9 billion. Of this amount, N$6.8 billion is the importation of fodder and feeds, including prepared animal feeds, which are the type of feeds sold by Feedmaster.

The trade statistics are not disaggregated and do not allow insight into the allocation of the N$6.8 billion to different feed subsectors. However, beef production comprises over 70% of total agricultural output per year, so assuming that most of the imported feeds are diverted for meat production, one could assume that at least N$3 to N$4 billion worth of complete cattle feed, feed supplements (e.g., mineral licks), and feed concentrates are imported per year.

Well-designed and tested bush-based feeds and feed supplements could contribute toward reducing the negative trade balance associated with the pilot integrated production plant of feeds. At a cost of N$3.5 billion per year, Namibia imports some 700,000 metric tonnes of feed (assuming a cost per tonne N$5,000).

8.5 GLOBAL AND REGIONAL MARKET OVERVIEW: CHARCOAL

8.5.1 Top charcoal exporting and importing countries

Production of charcoal has been increasing worldwide from 18 million tonnes in 1965 to 47 million tonnes in 2009, by which time Africa produced 65% of the charcoal in the world. The largest contributors to global export in charcoal, Paraguay (51%), India (31%), Indonesia (13%), Argentina (11%), and Samalaysia (5%), account for half of the charcoal exports. Since the introduction of biochar, demand and production are growing. India exported 18% of the wood charcoal it produced in 2014, the USA being its major importer.

Countries that have the highest share in global charcoal imports are Germany (9%), China (8%), Malaysia (8%), Japan (7%) and the Republic of Korea (6%). Germany imports charcoal worth 111 million US dollars, coming mainly from Poland (47%), Paraguay (12%), Nigeria (6.7%), France (6.3%), Bosnia and Herzegovina (5.3%), Ukraine (5.3%) and Indonesia (4.9%). The charcoal is mainly used in the leisure industry for barbecues and restaurants, as well as industrial purposes such as smelting. China imports 75 million USD of charcoal mainly from India, Myanmar, Colombia, Indonesia, Thailand and Ivory Coast. China’s growing demand for charcoal is driven by its silicon production, which accounts for 50% of the world production.

8.5.2 Charcoal production in Namibia

Namibian charcoal is well established on the market and offers accordingly significant expansion potential, since general demand is still growing. For example, over 40% of charcoal sold in the UK comes from Namibia.

According to NCA (Namibian Charcoal Association) invasive bush encroachment affects around 26 million hectares of Namibia’s farmland (there are different figures depending on publishing authorities in place, between 26 and 45 million hectares). As a way of managing this problem, farm owners have turned to charcoal production, using cleared bush to create charcoal. The Namibian charcoal industry is informal and fragmented, mixed with exploitation of average to poor environmental degradation and based on low technology and mainly unskilled labour. Namibia has high levels of unemployment, charcoal workers are often migrants from Angola and Namibia’s lower income region, Kavango.

8.5.3 Current and potential capacities as incentive for improvement

The Namibian charcoal market demonstrates the comparative advantages that are some of the key features of this market that could be further explored for sustainable development and increased contribution to the country’s economy.

- Namibia is the world's sixth largest charcoal exporter. 90% of the total production is exported, the main single market being South Africa. 30% of the exports to South Africa consists of bulk.
- The second biggest importer is the UK which received 22% of Namibia’s charcoal exports in 2015. In 2017, the total production of Namibia was approximately 180,000 tonnes, evenly split between South Africa and other markets. Namibian charcoal enters the consumer market under more than 15 different brand names, of which only a few are registered in Namibia, e.g. Jumbo, Etosha and Savannah. The rest enters the market through South African trademarks. Agents and distributors play an important role in marketing of Namibian charcoal.
- According to NCA reviews and further international business contacts and investigations, another 100,000 tonnes are considered possible to be exported. According to NCA, this includes also the opportunity to address an additional market segment that consists of the application of the produced retort charcoal as ‘restaurant charcoal’ because of its superior quality.
### 8.5.4 Structure of charcoal business in Namibia

The infographic on the next page shows in more detail the main structure of Namibia’s charcoal business. This structure also sets the foundation for how the project, with its production improvement suggestion, has to be integrated into the current business process, to take advantage of existing market contacts, in addition to the development of own and additional customer segments. Accordingly cooperation opportunities with processors will be addressed.

#### 8.5.5 Current drum kiln operations as reason for suggested improvement

There are sometimes also other arrangements in place, but the processor mostly acts as purchaser of the produced charcoal, picked up at the farm’s roadside. This represents a significant problem for tourism, since “the clean nature” requested from tourism is heavily charged from operating and smoking drum kilns on, and besides touristic routes due to widely visible smoke generation. Moreover, workers are of course harmed to a significant higher extent from smoke and gas emissions (CO₂, CH₄, other volatiles and non-condensable gases) directly at production sites.

The above mentioned problem will be significantly improved by introducing the suggested retort technology and will comply with current workers’ health protection developments and overall environmental regulations.

For that purpose, two processors have been visited to understand current business models and to develop mutually an appropriate improvement suggestion, which is based on higher yields and carbon content and fewer fines of the suggested retort process, and is appropriate also for higher priced end products.

### 8.5.6 Investigations and opportunities

Aiming to ensure the detailed understanding of the available opportunities for development of charcoal production in Namibia, the following major investigations were accomplished and respective action proposed:

- The largest processor, Jumbo charcoal in Okahandja, has exports of approx. 20,000 tonnes at a labour force of approx. 250, is concentrated currently on the UK, but does also exports to France, Greece and Portugal. As evidence that they also see opportunities in retort charcoal they dispose some retort charcoal pilot plants, which are not operative, but which can be understood as potential steps into the higher priced market segment of retort charcoal.

- Makara Bush Products in Oshikango delivers about 10,000 tonnes of charcoal per year, employs about 150 people and acts as purchaser of drum kiln produced charcoal. Processing includes collecting the raw charcoal from producers, sieving/softing, quality supervision, packaging and preparation for dispatch (similar to Jumbo). There are also some interests to market higher value charcoal products, which is already done with the production of briquettes, taking advantage of the low raw material costs of charcoal fines (1.5 mm particles on average). Makara’s business model includes also the production of drum kilns and their sales and rental to contractors or processors.

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**Table: Structure of charcoal business in Namibia**

<table>
<thead>
<tr>
<th>Functions</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary productions</td>
<td>- Cutting and stacking (manual, clearing)</td>
</tr>
<tr>
<td>- Transport to kiln</td>
<td></td>
</tr>
<tr>
<td>- On-farm burning of felled trees with charcoal from retort process</td>
<td></td>
</tr>
<tr>
<td>- Stockpiling; Quality control; screening; repackaging, transportation, containerising;</td>
<td></td>
</tr>
<tr>
<td>- Commercial scale: 3,500 tonnes per annum</td>
<td></td>
</tr>
<tr>
<td>- Local (low-tech, small scale) briquette producers, market share: 70%</td>
<td></td>
</tr>
<tr>
<td>- EU retailers (UK market share: 50%)</td>
<td></td>
</tr>
<tr>
<td>- EU retailers (UK market share: 50%)</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 8.6 - Drum kilns built in Oshikango and working for Oshikango (Makara bush products)**

**Figure 8.7 - Main structure of Namibias charcoal business in detail**

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28 Forest Stewardship Council Certificate established to promote the responsible management of the world’s forests.
Conclusion: UNIDO Project Implementation and Outlook
Namibia is a land of extraordinary beauty with an abundance of natural resources. One of these resources is the country's wealth of biomass in the form of various species of bush. The country has already determined legislation to care for the protection of this resource.

UNIDO, jointly with the national partners and with the financial support of the Government of Finland and Baoab Capital Ltd., is supporting the Government of Namibia in advancing the sustainable industrial development of Namibia by utilizing this abundance of biomass of invasive bush species for production of higher value-added final products. This project, named “Promoting Sustainable Bush-Processing Value Chains in Namibia,” encompasses the identification of technologies, testing of appropriate technology solutions for manufacturing these identified final products based on locally collected bush biomass. The identified technologies are to be transferred to Namibia and installed for further operationalization at a pilot processing plant to be designed and established for manufacturing of high-value livestock feed, charcoal (potentially also charcoal and/or “biochar”), and other selected products utilizing Acacia and other raw materials. Hence, the sustainable utilization of invasive bushes like Acacia helps to mitigate bush encroachment as a form of land degradation. Through these measures, higher levels of agricultural productivity can be achieved, resulting in better supply of food, increased resilience of farmers to droughts and reduced poverty, especially in rural communities. The improved provision of arable land for agricultural activities would result in increased capacities for local job creation and income and export generation. In addition, through controlling the spread of invasive species and sustainable use of available bushes, the tourism sector would also benefit through renewed access to underground water resources, the restoration of original rich scenery with native plants and wildlife.

As such, this report represents a convergence of feasibility study and market intelligence to provide a market-oriented sustainable business model to benefit from biomass production for production of competitive higher value-added products and facilitating job creation. This pilot production plant is to be equipped with modern innovative machinery, including biochar production equipment for production of charcoal, tar and distillates, bush cutting and chipping equipment, containerized feed mill and pelleting line. This plant is to be established at the land plot to be allocated by the national counterparts, in particular, the Ministry of Industrialization, Trade and SME Development (MITSMED) of Namibia and the Namibia Development Corporation (NDC).21

To enable the establishment of the pilot production plant, UNIDO will facilitate transfer of the identified technologies through procurement and installation of the machinery appropriate for the production of animal feed, charcoal and other by-products and suitable to Namibian conditions.

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In particular, the technologies to be transferred include:
- animal feed production plant with a capacity of approximately 4,000 tonnes/year;
- two charcoal production plants with a capacity of approximately 500 tonnes/year, whereby for both plants (animal feed and charcoal) their capacities are essentially dependent on personnel deployment, shift schedules and further optimization and are thus flexible;
- harvesting equipment required bush raw material.

In accordance with the strategic actions as defined in this report, the task is thus threefold:
- transfer of technologies and know-how to Namibia and respective procurement of equipment;
- the operationalization of the production plant, including ensuring the necessary pre-conditions for its sustainable production processes;
- ensuring the entrepreneurial conditions to make the investment an economic success.

The operationalization of the pilot production plant will include the testing and adaptation of the production processes in cooperation with the original equipment producers and Finnish expertise/academia including from the Seinäjoki University of Applied Science, training of the national experts on the operation of the equipment and technologies transferred as part of this project. Furthermore, in collaboration with Finnish academia and University of Namibia, the local experts will be trained to provide capacity building for harvesting and production of bush-based animal feed and charcoal in a sustainable manner.

One of the key aspects described in this report is the targeted business model and respective actions to ensure the economic success and sustainability of the pilot production plant. This aspect is of particular importance as both the available raw materials (bush biomass) and the targeted sales market allow to estimate the potential for replication of similar plants across the country, thereby demonstrating the potential of a significant contribution to Namibia’s economic development as a whole. As such, the business model considers the economic characteristics and design of the pilot production plant during the follow-up work on this project, since only a profitable operation and plant will be considered for further replication. In order to meet this economic challenge, the necessary entrepreneurial and business management technical support and respective capacity building activities to constitute the important part of the project need to be in place. Specifically, this means, among others, technical assistance in solving concrete entrepreneurial tasks such as:
- technical support in any operation and business operational issues relevant for the operationalization of the plant to meet the economic and profitability pre-conditions;
- support for the development and maintenance of the successful business model for the production processes and operation of the plant, starting from the raw material requirements, the different prescription-dependent supplements up to the production capacity, which also define the needs for equipment and personnel in the different modes of operation (including various mass balances and their influence on additional grazing areas);
- guidance to the national counterparts to ensure the sustainable business partnerships and operational contracts, such as secure supply of raw material, sales, future involvement of Namibian companies and institutes (including know-how transfer and product development);
- assistance in preparation of job descriptions and identification of personnel for the operating production plant to ensure management know-how in the final business planning stage, the construction and the operation phase;
- support for the overall business management of the plant through appropriate application of the business model to achieve the economic objective of the project.

In addition to the transferred animal feed and charcoal production technologies, sustainable process adaptation and development perspectives are being considered as a milestone action for this project, as the pilot production plant aims to support the generation of significant proprietary local know-how that would allow for stimulating a strong competitive positioning of the Namibian produce. This will take into account both the bush biomass characteristics and adaptation of the final goods to the needs of the local and external markets. The adaptation of the locally developed final product is to be specifically critical for appropriate positioning at the new market segment that is characterized by:
- development of suitable and competitive animal feed recipes that are affordable for the Namibian market;
- development of higher quality charcoal (“biochar”) potentially competitive at the national and international markets;
- potential for outdoor production of a new product “Arabic Gum” at the local and export markets.

These factors are part of the business model introduced for the pilot production plant that would serve as the basis for its testing and adaptation to ensure the sustainable and profitable operation of the pilot production plant. The business model further incorporates all parameters influencing revenues and costs determined so far, thereby providing the opportunity to model the economic outcome of the operational changes (in the design and development) and the potential profitability of the venture, thereby allowing prediction of the effects of each parameter influence on the pilot production plant’s profitability. At the same time, the business model includes a tailor made marketing and branding strategy for promotion and improved market access of the final products at the competitive local and export markets, including creation of unique brand and registration of the logo for the production entity and its produce.

As such, according to the estimates, the piloting of the production plant is expected to generate new jobs, stimulate development in Namibia with a multiplier of 3.5–2.5, and so for similar plants to be established in the region. This market-oriented sustainable business model provides the basis for establishment of a pilot production plant and formulation of tailor made business plans for the successful introduction of Namibian products targeting the emerging local and international markets. In addition, the project outcome supports the establishment of a sustainable income stream for the Namibian farmers, thereby contributing to Namibia’s national sustainable development objectives as well as the SDGs. By utilising invasive bush species to produce value-added products, this project will help Namibia generate jobs, including for women and marginalised individuals, increase food security and improve livelihoods, while restoring the environment and supporting climate sustainability.

22 Namibia Development Corporation (NDC) was being transformed into Namibia Industrial Development Agency (NIDA) as of November 2018.

86

87
Table of Figures

Figure 1.1 - Map of Namibia showing the highest densities of bush encroachment in the northern part of the country, where there is higher annual rainfall*

Figure 2.1 - Species and ecological roles

Figure 2.2 - Total extent of bush encroachment in Namibia with focus on main encroacher species*

Figure 2.3 - Illustration of the nutritional and mineral properties of encroacher bush species suitable for animal feed

Figure 2.4 - Illustration of the zero-waste approach to use an entire encroacher bush

Figure 3.1 - Fifteen (15) viable bush-processing value chains

Figure 3.2 - Employment type and estimated numbers for an operation producing 4,444 mt of feed

Figure 3.3 - High investment, research- and development-intensive bush-based value chains

Figure 3.3 - Moderate investment, medium research and development intensive bush-based value chains

Figure 3.4 - A front loader tractor removing the bush and a labourer manually trimming the tree to separate the biomass used for feed

Figure 3.5 - Tambuti Wilderness Farm: the extendable arm on the caterpillar and the scissor appliance

Figure 3.6 - Example of bush cut manually using an electric saw

Figure 4.1 - Bush roller in action

Figure 4.2 - Jukuri Hi 250 GT chipper, imported from Finland and in use at UNAM, Neudamm Campus (20 km east of Windhoek)

Figure 5.1 - Images showing the chipping machines and chips produced at Langbeen Farm, Dordabis, northeast of Windhoek

Figure 5.2 - Images showing the harvested bush material, chipping machine, and chips produced at BosPro Products

Figure 5.3 - Damaged Drotsky Hammermill at Neudamm Agricultural Campus

Figure 5.4 - Pelletizing line at Langbeen Farm with a sample of the pellets (the size of the pellets is 8 mm)

Figure 5.5 - Junkkari HJ 250 GT chipper, imported from Finland and in use at UNAM, Neudamm Campus (20 km east of Windhoek) and wood chips measuring an average 3 cm x 7 cm in size

Figure 5.6 - Images showing the harvesting bush material, chipping machine, and chips produced at BosPro Products

Figure 5.7 - Hammerrill at BosPro Products connected to a bag filling machine that facilitates production and packaging

Figure 5.8 - Conventional or standard concrete mixer used in Namibia

Figure 5.9 - Pelletizing production line at the UNAM Neudamm Campus

Figure 5.10 - Jumbo Charcoal's operation 4 km west of Okahandja: the sifter uses gravity to drop the charcoal down where it is separated according to size.

Figure 5.11 - Schematic of the containerised feed production system

Figure 5.12 - Schematic of the containerised charcoal production system

Figure 5.13 - Delivering the “triple-wins” through appropriate and sustainable technology