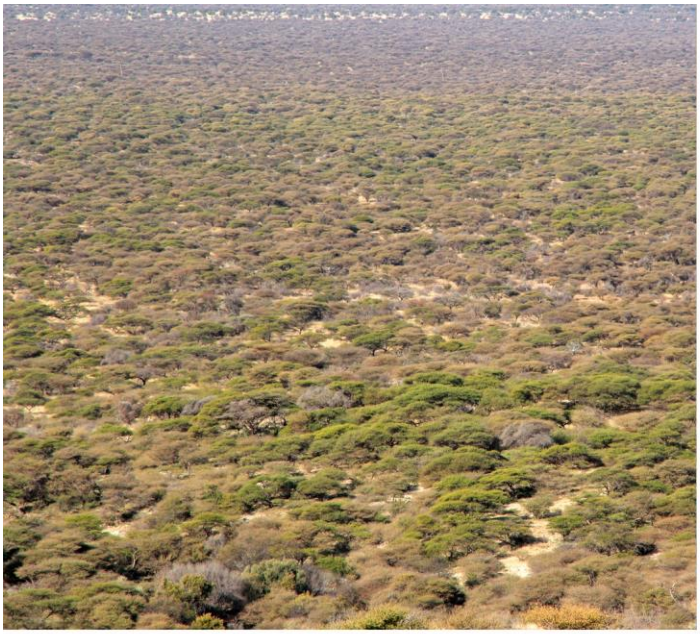
Support to De-bushing Project

Baseline Assessment for the De-Bushing Programme in Namibia

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Baseline Assessment for the De-Bushing Programme in Namibia

Imprint

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Support to De-bushing Project
Ministry of Agriculture, Water and Forestry/Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
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List of abbreviations

AEO	Agricultural Extension Officer
AET	Agricultural Extension Technician
AEZ	Agro-Ecological Zone
AgriBank	Agricultural Bank of Namibia
App.	Appendix
BE	Bush Equivalent of 1.5 m height
CBEND	Combating Bush Encroachment for Namibia's Development
CBRLM	Community-Based Rangeland and Livestock Management
CCF	Cheetah Conservation Fund
cm	Centimetre
CPD	Continuous Professional Development
DART	Directorate of Agricultural Research and Training
DEES	Directorate of Extension and Engineering Services
DoF	Directorate of Forestry at the MAWF
DRFN	Desert Research Foundation of Namibia
DSS	Decision Support System
ECB	Electricity Control Board of Namibia
EDF10	10th European Development Fund
EFF	Energy For Future
EU	European Union
FA	Farmers' Association
FNB	First National Bank Namibia
FSC	Forest Stewardship Council
FSP	Farmers' Support Programme
GIZ	Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
GRN	Government of the Republic of Namibia
GWh	Giga Watt hour
ha	Hectare(s)
HIV	Human Immuno-deficiency Virus
IPP	Independent Power Producer
kg	Kilogram
km	Kilometre
km^2	Square kilometre
kWh	Kilo Watt hour
LCOE	Levelised Cost of Energy
LSU	Large Stock Unit (450 kg)
l	Litre
m^3	cubic meter
MAWF	Ministry of Agriculture, Water and Forestry

MBN	Meat Board of Namibia
MCA-N	Millennium Challenge Account Namibia
ME	Metabolisable Energy
M&E	Monitoring and Evaluation
MET	Ministry of Environment and Tourism
MJ	Mega Joule
MLR	Ministry of Lands and Resettlement
mm	Millimetre
MME	Ministry of Mines and Energy
MTI	Ministry of Trade and Industry
MW	Mega Watt
NAU	Namibia Agricultural Union
NBC	Namibian Broadcasting Corporation
NCA	Northern Communal Area(s)
NCPA	Namibian Charcoal Producers' Association
NDP	National Development Plan
NECFU	Namibia Emerging Commercial Farmers' Union
NNFU	Namibia National Farmers' Union
no.	Number
NQA	Namibia Qualifications Authority
NR&BEF	Namibian Rangeland & Bush Encroachment Forum
NRF	Namibian Rangeland Forum
NRMP&S	National Rangeland Management Policy & Strategy
N$	Namibia dollar
NSI	Namibian Standards Institution
NTA	Namibia Training Authority
NYS	National Youth Service
OBI	Omariru Biomass Investments
O&L	Ohlthaver & List
p.a.	per annum
RCU	Rangeland Coordination Unit
SADC	Southern African Development Community
SEP	Strategic / Sector Execution Plan
SME	Small and medium enterprise(s)
S&T	Subsistence and travel allowance
t	metric tons
TIPEEG	Targeted Intervention Programme for Employment and Economic Growth
TWh	Terra Watt hour
WMC	Woodland Management Council
yr	Year

Executive summary

1. This baseline study attempts to sketch the situation on the ground in mid-2014 in terms of the three major Programme outcomes:
   a. Institutional and political framework conditions across the various relevant administrative levels that enables increased capacity of land owners to deal with encroacher bush sustainably
   b. Services that provide farmers with targeted advice and information on how to de-bush and utilise the wood, and
   c. Value addition to wood harvested from encroacher bush and obtained while de-bushing or thinning bush on the farm.

2. As far as bush encroachment in Namibia is concerned, the concept that "26 million hectares of Namibian farmland are bush-encroached" is vastly outdated, being based mainly on manual surveys performed in the early nineties of the previous century that all but ignored the powerful tool of landscape-level measurements by remote sensing. Various pieces of *ad hoc* research since then indicate that at least 75% of Namibia's land surface (i.e. roughly 62 million hectare), consisting of all vegetation and land units that are not climatological deserts (e.g. the Namib desert) or saline deserts (e.g. the Etosha pan) and all land uses (commercial farming, communal farming and conservation) are subject to bush encroachment at varying intensity (i.e. bush density). Every bush density (in bush equivalents/ha) exceeding twice the average annual rainfall (in millimetres) is considered "encroachment" although obviously, this leaves space for interpretation, as not all bush densities are equally deleterious in terms of land accessibility, land productivity, rangeland and animal productivity and economic profitability. However, a more classified approach that considers the effect of actual density on profitability still has to be developed, as is an update of actual bush densities and potential wood yield.

3. The question of "how much bush is controlled each year in Namibia" was investigated in different ways:
   d. Investigations into the sale of arboricides by major input suppliers and specialist bush control services in Namibia showed that arboricides sold in the year 2013/14 were enough to treat nearly 84,000 hectares of farm land chemically against encroacher bush. This investigation did not consider other means of controlling bush, e.g. manual, mechanical or biological control.
   e. A questionnaire-based rapid survey of mainly commercial farmers showed that 72 respondents had exposed 17.7% of the area of their farm land (82,447 ha) to bush control *over the years.* While this survey did not elucidate how much bush control was *currently* done, it did give valuable insights into the rationale behind on-farm bush control, the preferred methods used, the success of the methods and the reasons that motivate farmers to control more bush.
   f. Combining information gleaned from the sale of arboricides in 2013/14 and farmers' preferred method of bush control over the years shows that a total of nearly 128,000 ha of farm land may currently be treated against encroacher bush every year, by chemical, manual and mechanical means. Some of this area may have been treated a second or third time. In the absence of proper aftercare, benefits may not be as cumulative as expected.

4. All rangeland activities including bush control are in the process of being coordinated by a central body, provisionally called the "Rangeland Coordination Unit" housed in the Namibian Agricultural Union but serving all farmers and funded by the 10th European Development Fund until late 2018. It is recommended that the De-Bushing Programme coordinates with this effort.

5. A number of recent, comprehensive studies have detailed the regulatory framework that applies to sustainable rangeland management in general and to bush control in particular. It is recommended that the De-Bushing Programme acts on the problems identified in these studies.

6. It is generally accepted that bush control and sustainable rangeland management is its own best incentive, as it improves land productivity and farming profitability. However, additional incentives, mostly pertaining to financial support, political and legal factors are identified. Two major Namibian banks have acted on the financial incentives needed and their targeted loan schemes are detailed, as well as the potential for enhanced bush control if more money were made available for cheaper loans that also promote non-chemical means of controlling bush.

7. A sectoral monitoring and evaluation system is proposed to be incorporated into the soon-to-be-formed "Rangeland Coordination Unit", initiated by the Namibian Rangeland and Bush Encroachment Forum under the chairpersonship of the Director of Forestry in the MAWF, housed by the Namibia Agricultural Union and funded (for the next four years) by a 10th European Development Fund grant.

8. Currently, none of Namibia's three extension services offers dedicated bush control and wood utilisation advice to land users or industrialists, although bush control is certainly part of their advisory package to producers and land users. The characteristics of the extension services and their main challenges are detailed.

9. Five major value-addition chains using the wood of encroacher bush in Namibia are discussed:
   g. The industrial combustion value chain that uses wood or wood products like charcoal for heating and direct-firing of industrial combustion chambers such as furnaces and boilers
   h. The industrial energy value chain that uses wood or wood products to generate electricity at an industrial scale
   i. The domestic energy value chain that uses wood for domestic energy purposes
   j. The building materials value chain and
   k. The animal feedstuffs value chain.

   All but the industrial-scale energy value chain are currently fully operational in Namibia, but of vastly different capacity.

10. The charcoal industry is Namibia's oldest wood value chain and a good example of an industrial combustion value chain. It has existed as an industry for about 30 years and operates mainly on farms in northern and central Namibia. Land-users making charcoal off their land (either by themselves directly or by sub-contractor) are organised into the "Namibian Charcoal Producers' Association" which currently has more than 500 members. Most charcoal is made by 5,000-plus sub-contractors and individual workers who appear not to be organised. Most of the charcoal is delivered to nine factories that sift, sort and package it for export to South Africa and Europe. Between 60,000 and 158,000 tons of charcoal are exported annually. The industry is beset by lack of mechanisation, lack of control over harvesting, labour problems, health and environmental issues and has an exploitative image due to its labour practices and harvesting techniques. These problems have been well documented within the last decade. The FSC certification process conveys a distinct marketing advantage to qualifying charcoal producers and needs to be more widely accepted and applied. The charcoal industry needs to be better organised, structured and controlled in line with

its maturity, which would allow rapid expansion as the demand for charcoal, internationally, far exceeds the supply.

11. Only one Namibian institution uses encroacher wood to fire or co-fire its industrial combustion chambers. This is the Ohorongo Cement factory near Otjiwarongo, which needs a total of 85,000 tons of wood/year to fire its cement kilns. Currently, only about half this need is met, prompting Ohorongo to launch a 3rd party wood scheme whereby they offer to buy raw wood or wood chips from producers. This scheme has already attracted at least one bulk supplier of wood chips. Most of Ohorongo's wood is harvested within a 100 km radius of the cement factory. At least three other large Namibian institutions, Namibia Breweries, NamPower and MeatCo are considering refurbishing their combustion chambers to be co-fired with wood, or are at different stages of refurbishment. Various O&L subsidiaries are about to test the direct-firing of some of their industrial boilers with wood at their Windhoek brewery as well as organising a large-scale supply chain.

12. As a domestic energy value chain, the consumption of wood as firewood is huge: by some estimates, Namibians use about 440,000 tons of wood/year as firewood for own consumption and informally and another 45,000 t/yr is sold formally. Not all of this wood derives from encroacher bush, of course.

13. In addition to firewood, three smaller producers manufacture about 30,000 t of firewood products per year, intended primarily for domestic purposes but certainly with potential to fire industries:
    l. The Cheetah Conservation Foundation produces 7,500 – 10,000 t of their "BushBlok", a hollow log made from compressed wood chips, annually
    m. Omariru Biomass Investments produced about 10,000 t of "EcoLogs" annually until temporarily suspending operations in response to Ohorongo's 3rd party wood scheme, and
    n. Greencoal produced about 10,000 t of torrefied biomass recently, until beset by technical problems which caused a decline in production this year. While the origin of torrefied biomass was to supply domestic energy, this value chain probably has most potential at the industrial level.

14. Currently, there is no operational industrial-scale energy value chain of encroacher wood, although developments to use wood for industrial energy, primarily to generate electricity from biomass, are rapid and varied. Generally, there is huge interest to exploit the energy content of wood, specifically encroacher wood and many plans at various stages of readiness exist. It appears that industry efforts could be better coordinated and the supply side of encroacher wood could be better organised. The De-Bushing Programme could have an important role to play to assist the structuring of emerging industries brought about by constructive and transparent engagement of the different interest groups. The lack of this approach has been identified as a main hurdle in previous efforts to conduct large-scale de-bushing.

15. The building materials value chain of encroacher wood is small not well developed. As far as could be ascertained, only one formal outlet, Pupkewitz Megabuild, sells farm-made fence droppers and then only in one branch, serving mainly a high-density residential suburb of Windhoek with a lot of informal building activity. The use of farm-made fence droppers and posts on farms is huge but no production estimate could be made. Apparently, only one farmer uses encroacher wood very imaginatively to produce high-value gardening products such as bedding edgings, decorative mulch, and compost etc., sold informally to various town-based nurseries. There is also big interest in producing chip wood products but wood quality and security of supply are issues that deter

investment. This budding industry certainly has huge expansion potential (including producing for export) and is in dire need of stimulation (e.g. spreading the message of its potential), support (e.g. with labour arrangements and standardisation of products/product quality) and direction (e.g. innovative design of products).

16. A formal value chain to use encroacher wood in animal feeds does not exist in Namibia, probably because the main biochemical component of wood, lignin is completely indigestible, with countless scientific studies that elaborate this characteristic. Yet, farmer claims that home-made "bush feed" helped them sustain their animals during a drought or other lean times are legion. None have come to the stage of formal marketing, though some farm recipes are sold amongst farmers. One product, "Boskos", is imported from South Africa but is more expensive than lucerne pellets when sold in formal outlets. This value chain needs further investigation of successful case studies to identify under what conditions wood products could be used gainfully to enhance animal nutrition.

17. The baseline report makes some general recommendations pertaining to:
    o. The naming of the Programme
    p. The applicability of the Soil Conservation Act to the whole country
    q. The structuring of maturing industries and the taking of entrepreneurial risks
    r. The potential of bush control to considerably increase the "availability" of farm land to all those who wish to farm
    s. Suggestions on the location of pilot areas, and
    t. The need for the De-Bushing Programme to link budding wood-based industries to the SME-supporting sector.

    Recommendations end with 31 specific suggestions cropped from the text of the document.

18. The baseline report closes with a table of Programme performance indicators that are quantified, motivated and refer the reader to the relevant discussion in the text.

Brief Terms of Reference

The baseline data and information to be generated by this consultancy includes the following:

1 Scope of bush encroachment and de-bushing in Namibia

It is of utmost importance to have a baseline of the current bush encroachment situation and de-bushing activities, both in quantity and quality terms. The information / data required include:

- agricultural output / productivity of farmland concerned
- scope of bush encroachment in Namibia (e.g. area size, number of households)
- quality and reliability of data available
- extent of de-bushing activities (area size; no of organisations / individuals involved)
- comparison of de-bushing categories, e.g. labour intensive, mechanized, chemical, commercial/communal.

The analysis should result in a recommendation / assessment of potential priority pilot areas for the de-bushing programme be it geographical, sectoral or otherwise.

2 Policy and Institutional framework for de-bushing

Bush encroachment and de-bushing has been a topic of considerable political prominence for many years. A policy and institutional framework has (been) developed over time. The enabling framework needs to be reviewed and possibly complemented and/or enhanced. Information / data required include:

- Availability of a National Policy on bush encroachment a/o de-bushing or sector policies that impact on bush encroachment a/o de-bushing (update of 2011 compilation and assessment; focus on need for enhancement a/o enforcement a/o alignment of sector policies)
- Availability of a National Strategy, Support Programme a/o Incentive Scheme for bush encroachment a/o de-bushing
- Availability of a National Coordinating Body and or other institutional arrangement addressing the bush encroachment and de-bushing sector.

The analysis should result in recommendation regarding enhancement of the policy, support and institutional environment.

3 Promotion and support schemes for de-bushing

Future support to de-bushing will centre around an envisaged De-bushing Advisory Service. As a starting point it is important to know about current support schemes, and the level of utilization. Required information/data include:

- Availability of advisory services, and their level of their utilization (no of communal/commercial farmers …)
- Availability of advisory a/o support packages tailored to the needs of defined target groups (e.g. commercial/communal; cattle incl. game farming; wider resource utilization …), and their level of utilisation
- Availability of financial support programmes / incentive schemes for de-bushing, and the level of their utilization (No of farmers using financial support schemes …)
- Bush Expert Decision Support System: level of utilization (current No of users / accesses) and financing strategy / basis.

The analysis is meant to result in parameters for the institutional and operational design of the DAS.

4 Value chains for bush/biomass

Acknowledging the cost level of de-bushing of farmland, bush utilisation opportunities are seen as the potential trigger to mobilise large scale de-bushing programs. Thus, the identification of viable / feasible value addition opportunities are critical. Information / data required include the following:

- Real cost of de-bushing according to categories, taking into consideration economies of scale
- Previous trials of biomass based value addition opportunities in Namibia
- Current value addition opportunities that are under consideration / research
- Existing and commercially viable value chains
- Potential a/o future value addition opportunities under consideration of int. experiences
- No of female / male farmers/workers involved biomass value chains.

The analysis is meant to lead into a list of priority value addition opportunities and supporting value chains that are likely to be viable in the very specific Namibia environmental and socio-economic and geographical context.

5 Output/ Deliverables

The consultant is expected to document the results of the systematic review in the form of a baseline report, focusing on the above mentioned baseline information but also producing resulting strategic recommendations as well as recommendations on how to monitor the progress of the program according to the indicators mentioned.

The document will also:

1. Identify risks and impacts (if any) and the source of information on which they are based.
2. Take the cross sectoral character of the program into account and overview of the interlinkages between gender and HIV and Aids.
3. Guide towards a lean but efficient M& E system including a critical review of the indicators originally proposed.

1. Introduction

Few natural resources have such an advantage as Namibia's encroacher bush offers: even if it is extracted exploitatively, its consumption would still have beneficial effects on the environment and farming enterprises. Namibia's encroacher bush grows "for free", without a cent's investment. Since it is severely damaging to the environment, extensive livestock and game farming ("ranching") and ecotourism, it has an immense hidden cost, that of foregone production. If it is extracted from the rangeland in such a way that it never re-grows again, most every land user would be extremely happy. Its sustainable harvest, i.e. so that it re-grows again for a future, second harvest, would raise many a sceptical eyebrow in Namibia. Its extraction is also less inflation-prone than that of comparable fossil fuels. What a unique resource; what a unique business opportunity!

Yet, few Namibian land users actually de-bush or control encroacher bush, let alone add value to extracted encroacher bush. Why not, if one need not worry about exploitation and could get rid of hidden costs? The answer to this conundrum has many facets, and the list below is by no means complete:

- Namibia's is a complacent society beholden to re-action rather than pro-action. The country's renewable energy sector is so poorly developed that one would think it is not blessed with ample renewable energy sources. The possibility to use encroacher bush for other purposes than farming, especially for electricity generation, would probably not have been seriously considered if the country, in fact the whole SADC region, would not be facing a dramatic power shortage. Complacency dovetails with resistance to forego some short-term gain for longer term sustainability.
- Bush encroachment is a slow, sporadic process. It happens "under the radar" for a long period of time, so is difficult to realise as "dangerous". Because it is such a gradual process, farmers find it easy to adjust to it over time, avoiding or delaying expensive emergency reactions. One learns to live with bush encroachment.
- So far, the problem has been one of Namibian land users. Encroacher bush is a "problem" to farming and not a business opportunity for industries other than agriculture. A mind-set shift is needed from "this is not our problem but that of farmers" to "this is a business opportunity for me".
- Control of encroacher bush costs a lot of money, which farmers operating in an arid, perceived hostile, highly variable and unpredictable environment are very reluctant to spend. Usually, as long as it rains "enough", farmers manage to scrape by without addressing encroacher bush on large areas. Effective bush control measures would have to be applied to thousands of hectares, not just on a small scale!
- For farmers, it was until recently (about 2009) cheaper to buy a new farm than to control encroacher bush on their own farm. The encroachment problem was often side-stepped by acquiring new land and selling encroached land to others, often newcomers to farming and Government's resettlement agencies. Only recently have these economics turned around, with a vengeance! Price relations have changed such that in 2014, the sale of one ox pays for bush control on 23 hectares (applying bromacil manually at 2 kg/ha in the Grootfontein district and beef prices of N$29/kg carcass mass) whereas it paid for only 5 hectares of bush control in 1993[1].
- Those farmers who control bush often find that they do not have enough resources left to buy additional livestock needed to harvest the extra grass produced. In the Grootfontein district for example, chemical bush control increases the carrying capacity of natural rangeland from 20.4

1 : ZENSI, P., 2014. Increasing livestock production to attain a higher profit in Namibian rangelands. *Proceedings* of the 18th Namibian Rangeland Forum p. 9, Gobabis, Namibia.

ha/Large Stock Unit (LSU) to 9.6 ha/LSU, increases beef production from 6.5 kg/ha to 13.9 kg/ha and increases profit from beef by N$67/ha/year, but it costs N$283/ha to acquire the extra cattle! Some farmers cannot afford to stock up after de-bushing, thus are unable to recover the expense of initial bush control. Generally, financial incentives offered so far are perceived as not attractive enough to support bush control and wood extraction.

- Very few farmers and institutions have tried adding value to extracted encroacher bush because this costs even more money, at least initially. Bush utilisation would take some research and development, which is comparatively expensive and an additional burden on entrepreneurs. Due to Namibia's small population, the inland market is small, not very sophisticated and does not offer many opportunities to sell bush products. The "pull' factor that should encourage wood extraction and a value-addition mind set is thus poorly developed. This is exacerbated by the poorly organised supply side of bush as very few large scale, successful bush extraction operations exist in Namibia.
- Economies of scale at the national and regional level and disorganisation on the supply side would remain a challenge to rapidly expanding production of bush products and recovery of start-up costs. At the same time, economies of scale at the land user level make the implementation of bush control and value addition prohibitively expensive, especially with poor value chain support.
- In communal areas, the wood of encroacher and other bush is used extensively for a variety of purposes so that landscape-level de-bushing programmes are not desirable. In fact, bush around some larger settlements has become depleted.

➔ Government has until recently not seriously considered assisting commercial farmers to control bush. After all, their inappropriate land use was perceived to contribute to the problem, so why would anyone else but themselves have to address it?

The challenge to the De-Bushing Programme is thus to facilitate this mind-shift from "problem" to "opportunity". Thus, one of the prime objectives of the De-Bushing Programme is to explore and encourage the utilisation of and value addition to encroacher bush wood in various value chains; encouraging bush harvest on farms (commercial and communal) in an ecologically sensible manner that leads to improved rangeland condition, increased animal productivity and enhances eco-tourism. This cannot happen without expanding the capacity of land users and the country to harvest and utilise encroacher bush, serving them with sound technical advice, organising the supply of bush, implementing a single coordinating body that encourages, harmonises and facilitates, identifies gaps and mobilises resources, etc. The De-Bushing Programme seeks to optimise the enabling policy and institutional framework that regulates, organises and supports this nascent industry and boosts promotion and support schemes.

This baseline report seeks to establish the situation on the ground in terms of bush control and value addition at the start of the operational phase of the De-Bushing Programme in September 2014. Namibia is still in the process of building an "information/statistics gathering sector" and many statistics that could have been useful were virtually impossible to collect in the timeframe of this report. In the course of gathering relevant information, many opportunities for fruitful engagement were identified and these are mentioned to assist the Project Team in their further course of action. Also, the author tried to put things into a broader perspective based on the prevailing sentiments to point out further opportunities or potential hurdles, but this is obviously subjective and open to interpretation. It is hoped that this broader interpretation of the Terms of Reference will be a useful tool for the Project Team.

2. Methodology

The methodology employed to execute this baseline assessment included three major activities:

i. Review of the relevant literature formed the backbone of the information collected. The Programme Team was very helpful in supplying relevant literature (see also: App. I).

ii. Interpretation of this information, its relevance and inter-connectedness, stakeholder perceptions and newest developments were then established by face-to-face interviews with selected stakeholders or their designated representatives (App. II). While much effort was expanded to personally interview all relevant stakeholders, this is nigh impossible. Typical scheduling limitations and tight project deadlines restricted the list of stakeholders interviewed personally to those listed in App. II. In addition, e-mailed communications with these and other stakeholders were also conducted but are not listed. Often, stakeholders imparted confidential information and thus not all pieces of important information in the text are referenced to individually identified stakeholders.

iii. A rapid survey of bush encroachment control was conducted amongst the farming community (commercial and communal) to get more information on the extent of de-bushing on Namibian farms. A questionnaire was designed (App. III) and advertised repeatedly in print, radio and electronic media. It was included in the 27 August 2014 edition of Namibia's largest daily newspaper "The Namibian", of which weekday editions sell approx. 50,000 copies, along with an explanatory, technical article on bush control in Namibia, in English. The questionnaire was bound into the September issue of the monthly glossy journal "AgriForum" of which 4,700 copies are distributed country-wide each month along with an explanatory, technical article on bush control, in Afrikaans. The AgriForum gets sent to all registered members of the Namibian Agricultural Union (NAU) and is on sale in bookshops and stores with an agricultural focus. The questionnaire was also placed on the websites of the NAU and The Namibian newspaper and this was advertised repeatedly, amongst others via the e-mail messaging service of the NAU that gets sent out to several thousand e-mail addresses each week. The questionnaire was sent via e-mail personally to all chairpersons of the 72 regional and local farmers' associations (FA) registered with the NAU, with the request to please distribute is to FA members. Finally, personal interviews were aired repeatedly in late August and early September 2014 over four radio stations (English, Afrikaans and German services of the NBC and Hitradio) to explain the De-Bushing Programme and alert farmers to the questionnaire. The intention is also to give this audience feedback on the results of the survey once this baseline assessment is concluded successfully.

This information was processed, assessed and compiled into the report in front of the reader now. Information was exchanged with the Programme Team and progress reported on a weekly basis, meeting in "Bush House" in 9 Haydn Street, Windhoek West. At least three draft reports were edited and streamlined in countless meetings with the Programme Team and its members, especially the Team Leader, Mr. Frank Gschwender. At this stage it is appropriate to thank the Programme Team for their time and extremely valuable inputs into this report!

If reference is made in the text to "anecdotal" evidence, this indicates a data gap that subsequent detail studies should attempt to close, if relevant to the Programme.

3. The extent of bush encroachment and de-bushing in Namibia

3.1 Extent of bush encroachment in Namibia

"Bush encroachment" refers to the thickening of indigenous woody plants in savanna and woodland vegetation types. The offending woody plants are indigenous and not aliens, that's why they should be termed "encroachers" and not "invaders". An often-used thumb rule (De Klerk, 2004) states that if the numerical density of 1.5 m-high bush equivalents (BE) exceeds twice the average annual rainfall (in mm), the area is bush-encroached. For example, the average bush density in an area that receives 300 mm of rainfall p.a. over the long term should not exceed 600 BE/ha. The woody component could be comprised of:

- 1,200 dwarf shrubs of average height 75 cm, i.e. 1 dwarf shrub=75 cm height = ½ BE or
- 600 bushes of 1.5 m height or
- 200 trees of 4.5 m height, i.e. 1 tree = 4.5 m height = 3 BE or
- any combination thereof.

Importantly, the bush density should not be the same all over the landscape. Rather, the average density should comprise thicker patches of dense bush and more open patches with less bush and contain a diversity of woody species of different sizes and ages.

Picture 1: Rangeland that is bush-encroached in the Grootfontein district

Picture 2: Rangeland that is not bush-encroached

Bush encroachment can potentially affect all areas of Namibia but the 16% of the land surface that is hyper-arid: the climatic (Namib) or saline (Etosha) desert. 84% of Namibia is composed of savanna and woodland vegetation types that are characterised by a continuous herbaceous layer dominated by grasses in a competitive balance with a broken (fragmented) woody layer. These vegetation types are inherently prone to bush thickening and encroachment. In woodlands, woody plants tend to be denser and taller than in savannas.

There is an inherent ecological, successional tendency of the woody layer to densify from an open savanna towards denser woodland and eventually, into a (sub-humid or equatorial) forest if the competitive balance between herbaceous and woody plants are disrupted. In other words, "bush encroachment" is a natural process. In pristine environments, the expansion of the woody component is contained by low or variable rainfall, infertile or shallow soil, regular high-intensity fires and intense browsing pressure. Man's interference is reducing the effectiveness of some of these wood-containing forces (especially fire and browsing pressure) and adds new drivers that favour woody expansion. In Namibia for example, over-reliance on grazing livestock species and non-adaptive grazing methods weaken the grass sward and its competitive ability to contain the woody (browse) component. Fire is still seen as a destructive force that has to be eliminated, thus facilitating the expansion of the woody component. More recently, environmental pollution has raised atmospheric carbon dioxide levels that "fertilize" woody plants (predominantly of the C_3-photosynthetic type in Namibia) at the expense of the grasses (predominantly of the C_4-photosynthetic type in Namibia). In short, natural and man-made forces increasingly gang up on grasses and favour bush encroachment, or expansion of woody plants into areas (large) and patches (small) where they did not occur in recent history.

3.1.1 Encroachment by indigenous woody plants

Bush encroachment already occurred in Namibia in patches in pre-colonial times, but it accelerated quickly to the landscape level with technological advances in land use methods since the 1940's (boreholes, fences and firefighting technology, primarily). It was recognised as a problem of national proportion in the 1960's. Mr. Bessie Bester, a researcher in the Ministry of Agriculture (since retired), raised awareness of the problem to a new level and estimated in 1998/99 that 17.5 million hectares in Namibia were affected by bush encroachment[2], recording maximum densities of 21,400 bush/ha. He excluded communal farming areas and the dwarf shrub savanna in southern Namibia from this estimate, although acknowledging that these areas were also affected.

Mr. Nico de Klerk included some of these areas in his comprehensive overview of bush encroachment[3], thus raising the area affected to 26 million hectares of "woodland savanna" in Namibia and calculated an economic loss of N$700 million/year due to bush encroachment. He estimated bush density in Namibia's 15 major agro-ecological zones (AEZ) as follows:

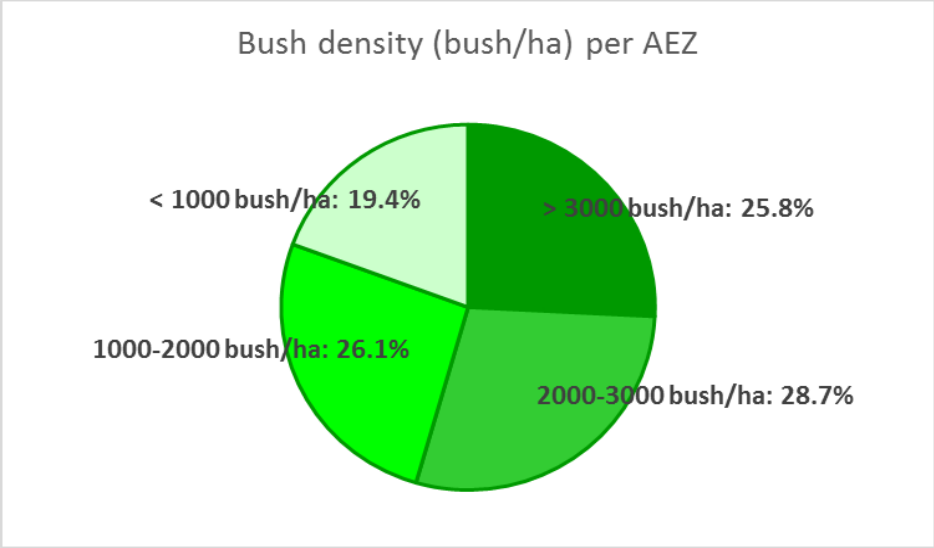

Chart 1: Bush density per agro-ecological zones

This was measured in 2,267 plots country-wide. The dominant species in these plots were:

2 : BESTER, F.V., 1998/99. Major problem: bush species and densities in Namibia. Agricola 10: 1-3.
3 : DE KLERK, J.N., 2004. Bush Encroachment in Namibia. Ministry of Environment and Tourism, Windhoek, Namibia.

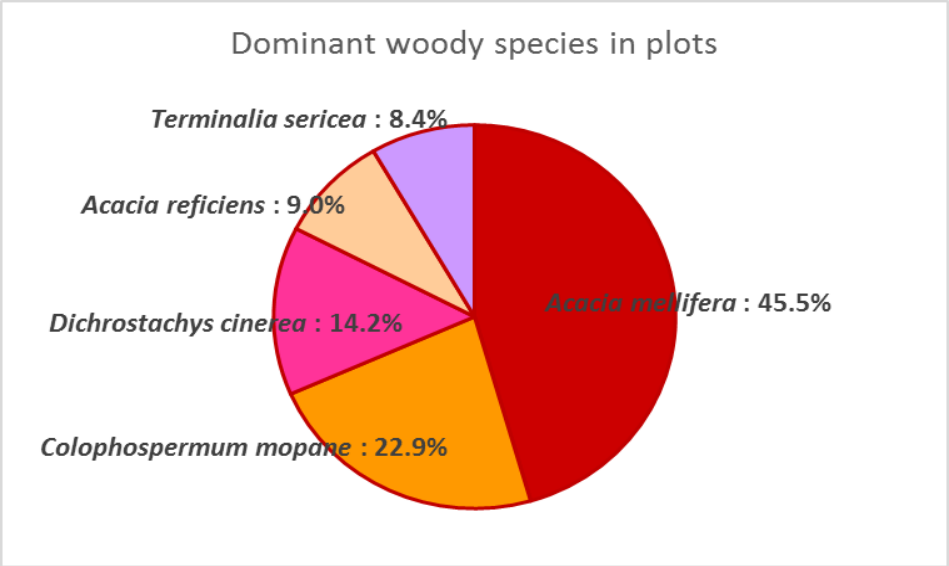

Chart 2: Dominant woody species

According to De Klerk (2004), the three most bush-encroached vegetation units were:

- Tamboti woodlands were most densely encroached as 94% of plots contained > 2,000 bush/ha and were classified as "densely" or "very densely" encroached,
- Karstveld, where 76-92% of plots had > 2,000 bush/ha and
- tree savanna and woodlands, where 78% of plots had > 2,000 bush/ha.

The three least encroached vegetation units were:

- Acacia hilly shrubland and inselbergs of the western escarpment and Namib desert, where only 15% of plots had > 2,000 bush/ha,
- shrubland of the central escarpment, where only 23% of plots had > 2,000 bush/ha and
- Burkea/Baikiaea woodlands, where only 39% of plots had > 2,000 bush/ha.

He calculated that 80-85% of the density distribution of bush on a macro-scale was the result of rainfall, with geology, terrain and soil contributing most of the remaining 15-20%. Already at that stage, De Klerk concluded that "approximately 80% of the study area contains more than 1,000 bushes per hectare and is subject to huge losses in land productivity". It affected 65,000 communal households and 6,283 commercial farmers and their farm workers.

More recently, Mr. Leon Lubbe quantified the areas in south-eastern Namibia affected by bush encroachment[4]. He is still busy with an assessment of south-western Namibia but already it looks like the whole of the karooid dwarf shrub savanna in southern Namibia is affected by bush encroachment, with densities as high as 18,000 bush (mainly *Rhigozum trichotomum*) being recorded per hectare. Two or three of these dwarf shrubs are equivalent to one BE so that 18,000 dwarf shrubs/ha translate into about 9,000 BE/ha which is 30 times more than the average annual rainfall. The average bush encroachment would be much less than this extreme level, but still considerably more than twice the average annual rainfall (the "norm" above which a rangeland is considered bush-encroached).

4 : LUBBE, L.G., 2013. Potential carrying capacity in northern and south-eastern Namibia adjusted to bush density. *Agricola* 23: 20-24.

These estimates still exclude most parts of the northern communal areas (NCA), probably 25% of Namibia's land surface. No landscape-level estimate of bush encroachment in the NCA is available, despite the fact that woodiness in Namibia increases from south-west to north-east.
Rothauge recently measured on average 4,292 BE/ha (equivalent to 10 x average annual rainfall) on eight sites in the NCA, varying from 2,366 BE/ha in the drier, western Kaokoveld (equivalent to 8 to 10 x average annual rainfall) to 5,157 BE/ha in the moister, eastern Kalahari Sand Plateau in the Kavango region (equivalent to 7 to 9 x average annual rainfall) as part of a Millennium Challenge Account Namibia (MCA-N) project[5]. Alarmingly, he also recorded an average of 4,246 woody seedlings/ha, indicating that the next generation of woody plants is ready to augment or replace the current woody generation if conditions are conducive. He also recorded that the dry yield of wood more than 2 cm in diameter was about 18.5 tons/ha on average across these eight NCA sites. In the Zambezi region, probably Namibia's most wooded area, Rothauge[6] measured an average of 8,007 BE/ha (equivalent to 12 x average annual rainfall) on two sites, plus 1,125 woody seedlings/ha and a dry wood (> 2 cm diameter) yield of 31.0 t/ha on savanna and 182.7 t/ha on forested transects.

Anecdotally, only the arid karooid veld in the far south-west (but outside the winter-rainfall Sperrgebiet desert), central Damaraland vegetation and far-eastern Bushmanland is not bush-encroached. These statistics (Table 1) indicate that at least 90% of Namibia's karooid, savanna and woodland areas[7] are affected by bush encroachment, where bush is denser (numerically) than 2 x average annual rainfall. The encroached area thus represents at least 75% of Namibia's land surface; roughly 62 million hectares. Therefore, there is hardly a rural household that is not affected by bush encroachment. Unfortunately, too little of this estimate is based on systematically collected, really measured data and too much on expert opinion.

Table 1: Development of bush encroachment assessments in Namibia over time

Year	Author	Area affected (ha)	Regions affected	Max. bush density
1998/99	Bester	17.5 million	Commercial farming areas north of Rehoboth	21,400 bush/ha
2004	De Klerk	26 million	Commercial farming area north of Rehoboth plus northern Kunene	10,000 bush/ha
2013	Lubbe	n/a	South-eastern Namibia	18,000 bush/ha
2014	Rothauge	8 sites	Kunene to Kavango regions	2,366-5,157 BE/ha
2014	Rothauge	2 sites	Zambezi region	8,007 BE/ha

Obviously, there are degrees of bush encroachment and not all areas are affected equally. The severity of negative impacts on grazing, accessibility and groundwater recharge and positive impact on wood yield depends not only on bush density but also on species and thorniness. The map[8] below classifies bush encroachment in the main affected areas by species and density and was compiled by Bester in 1990:

5 : ROTHAUGE, A., 2014. *Baseline Survey of Animal Nutrition in the Northern Communal Areas of Namibia.* Final report, Millennium Challenge Account Namibia, Windhoek, Namibia.
6 : ROTHAUGE, A., 2014. *Ecological Studies at two Quarantine Stations in the Zambezi Region.* Final report, Millennium Challenge Account Namibia, Windhoek, Namibia.
7 : 16% of Namibia's surface area of 823,680 km^2 is desert. The remaining 84% are karooid, savanna and woodland vegetation types prone to bush encroachment.
8 : BESTER, F.V., 1998/99. *Ibid.*

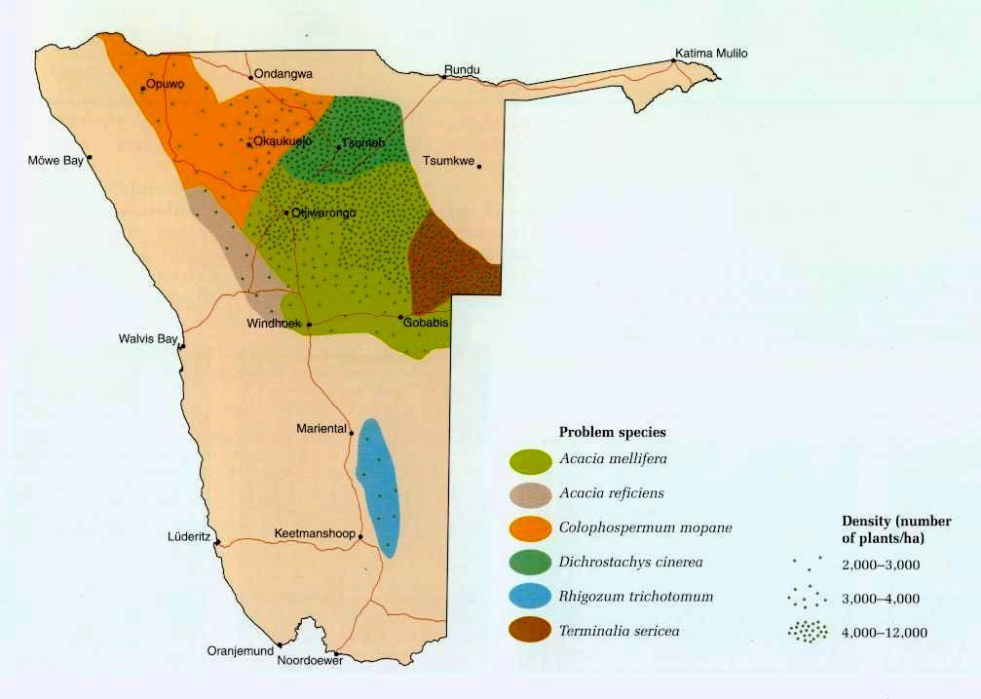

Figure 1: Besters's bush encroachment map

Based on this rather outdated map, a more qualified assessment of bush encroachment would estimate that, for example, an average *Dichrostachys cinerea* bush in the Tsumeb area (the most severely affected region indicated on the map, indicated in dark green) is about 3 m tall, i.e. equivalent to 2 standardised BE. At an average density of 8,000 *Dichrostachys cinerea* bushes per hectare in this area, the average bush density is 16,000 BE/ha which is 27 times the average annual rainfall of 550-600 mm and represents very severe encroachment. In contrast, average bush density in southern Namibia is only 2,500 *Rhigozum trichotomum* bushes per hectare (light blue area on the map). Since *Rhigozum trichotomum* bushes seldom reach 1 m in height, two such bushes would equal 1 BE and thus 2,500 *Rhigozum trichotomum* bushes/ha equal only 1,250 BE/ha. This is however still about 10 times the average annual rainfall of 100-150 mm and thus quite a severe infection. In fact, some ecologists would argue that 10 x bush encroachment in an arid area is just as bad as 27 x bush encroachment in a sub-humid area.

This approach was followed by Lubbe (2013). He calculated the following bush encroachment classes for northern and central Namibia based on Bester's 1990 map and related them to the carrying capacity map of 2003, as follows:

Table 2: Bush encroachment classes

Bush density (BE/ha) deduced from Bester (1990)	**Productivity related to 2003 carrying capacity**
≤ 900	100%
901-3,500	90%
3,501-6,100	70%
6,101-8,700	40%
8,701-11,300	20%
≥ 11,301	10%

This is instructive as it shows clearly that the decline in grazing capacity in response to increasing bush density is exponential; slow at lesser densities and declining rapidly at higher densities. This specific application of this approach is limited because it is still based on the outdated survey of Bester (1990) and misleading in that it compares bush density to the carrying capacity of a single year, when carrying capacity actually varies greatly from year to year due to fluctuating rainfall. The 2002/03 rainy season, the basis of the 2003 carrying capacity map, was above-average in northern and average in central Namibia. But it is a promising approach that still needs to be improved and fine-tuned by the De-Bushing Programme.

Most of the easily-encroaching woody species are hardwood species. Anecdotal observations and scientific surveys indicate that national parks and conservancy areas are just as much affected as commercial and communal ranching areas. This implies that all these different land uses facilitate the thickening of indigenous woody plant species; so there must be common drivers involved. This has implications for bush control, as common drivers and processes mean that similar control methods can be used across different land use systems in Namibia.

Why such alarm over a natural process that is merely accelerated by man? After all, most bush-encroached areas are highly productive and fairly stable ecosystems that offer plentiful feed to browsers and protect themselves from fierce fires. If Namibia was not so reliant on grazing livestock (mainly cattle and sheep, but also equines), bush encroachment would presumably not matter much. However, bush encroachment can reduce the grass-based carrying capacity ("grazing capacity") to less than one-tenth of the original, resulting in severe losses to individual ranchers and the nation as a whole. The loss of grazing capacity is due to overwhelming bush competition that reduces grass yield *per se* as well as changing the botanical composition of the grass sward towards more xerophytic, less productive, palatable, nutritious and resilient grass species. Changes in the grass sward are exacerbated by the inappropriate grazing methods practised for decades now in both commercial and communal ranching areas.

The newly-formulated National Rangeland Management Policy and Strategy[9] (chapter 4.2, Annexure B: The economics of good rangeland management) puts the direct losses due to the bush encroachment/weakened grass sward complex at N$1.4 billion each year (updated to N$1.6 billion in the STEAG study of 2013). In a country where more than 70% of the population depends on agricultural (mainly livestock) production, this is a huge driver towards poverty! The devastating environmental and indirect economic impacts of bush encroachment are well documented by De Klerk (2004). For example, bush encroachment reduces groundwater reserves and limits groundwater recharge and extraction rates[10]. This is a critical consequence for an arid country like Namibia. Bush encroachment and the associated pioneer-stage herbaceous layer are a sign that the landscape has become drier. Therefore, artificial drought events ("man-made droughts") will become more frequent and resilience to withstand harsh natural events (e.g. drought, out-of-season wildfires, termites, locusts and climate change events) decreases. Less measurable is the impact of bush encroachment on the tourism industry. Bush invasion and thickening changes the wide, open landscape that attracts tourists so much and reduces visibility (of, for example, game animals in protected areas) and biodiversity. So far, its impact on tourist arrivals has not been determined.

9 : MINISTRY OF AGRICULTURE, WATER AND FORESTRY, 2012. National Rangeland Management Policy (Part I) & Strategy (Part II): Restoring Namibia's Rangelands. Policy document of MAWF, Windhoek, Namibia.

10 : Frank Bockmühl on the "Platveld Aquifer Study" of 2009, reporting to the MAWF; and
CHRISTIAN, C., J.N. DE KLERK, F. BOCKMŰHL, B. VAN DER MERWE & A. MOSTERT, 2010. *Desk Top Study on the Effect of Bush Encroachment on Groundwater Resources in Namibia.* GIZ-sponsored consultant's report, Namibia Agricultural Union, Windhoek, Namibia.

The negative impact of bush thickening on biodiversity has also been well documented, in Namibia primarily by Dr. Dave Joubert of the Polytechnic. An example is the Cape vulture, now extinct in Namibia. It is a cliff-breeding vulture that nested only on the steep, rocky slopes of the Waterberg Plateau. It is also one of the heaviest vultures and needs to run some distance before it can take off and fly. The landscape around the Waterberg is one of the most densely encroached in Namibia, offering the Cape vulture too little open space to take off after landing. Thus, it was unable to feed on the animal carcasses littering the area and died out in the early 2000's. If encroacher bush in this landscape is thinned, the re-introduced Cape vulture may again inhabit it with success.

No-one has yet researched the growth rate of encroacher bush although Zimmermann & Joubert (2002)[11] postulated that small bush may regenerate for a second harvest within 15-20 years, mature bush may regenerate within 50-70 years and large trees may take centuries to regenerate for a second harvest, which invariably would yield less than the first harvest.

There is certainly a need for these assumptions and inferences relating to the extent of bush encroachment in Namibia to be validated by "real" (quantitatively measured) data and to be updated to cover the whole country. This is an area of applied research in which the De-Bushing Programme might assist as it feeds into the proposed bush information system. Too much of the perceived wisdom arises from "expert opinion" rather than hard fact. This proposed research overlaps with the MLR's need to establish a representative, accurate and credible grazing capacity data base (map) of Namibia for the purpose of determining fair and transparent land productivity values (another GIZ-supported programme). Preferably, a country-level assessment (by remote sensing techniques) should be accurate enough to identify high wood-yield sites on a small scale so that their wood yield can then be followed up and verified by local level methods.

3.1.2 Encroachment by alien invasive woody plants

Alien invasive woody plants are not usually included in the term "bush encroachment" but are briefly discussed here as they are important. The most widespread and dangerous alien invasive woody plant in Namibia is certainly *Prosopis glandulosa*[12] and others of its 44 species and hybrids. Originally introduced to southern Africa from Central America as a fodder plant and sand binder in the late nineteenth century and by the German botanist Dinter to Namibia in 1912, it is nearly perfectly adapted to the demanding, hostile eco-physical conditions of the semi-arid savannas of south-western Namibia. It produces much valuable fodder in leaf and pod for livestock. It dominates native vegetation and transforms the entire landscape, altering the structure and functioning of ecosystems. It has invaded 8,540 ha of riparian ecosystems (drainage lines), disturbed sites and human settlement areas in areas of less than 250 mm rain per year preferentially, but by no means exclusively. However, *Prosopis* invasion is scarce in areas of more than 400 mm/year and non-alkaline soils. This means that *Prosopis* can potentially invade 50,000 ha of high-potential, moist ecosystems in the two-thirds of Namibia that are arid (< 400 mm/year). This may be an exceedingly small area of the country but with immense rangeland and agronomic potential. Here, *Prosopis* may evapo-transpire more than 15% of the total water, seriously impact catchment water yield, choke river channels, drain scarce riverine wetlands and suppress native, diverse riverine vegetation.

11 : ZIMMERMANN, I. & D.F. JOUBERT, 2002. A crude quantification of wood that is and can be harvested from bush thickening species in Namibia. *Proc.* 1st National Forestry Research Workshop 9: 56-66, 12-13 March 2002, Ministry of Environment & Tourism, Windhoek, Namibia.
12 : SMIT, P., 2005. *Geo-Ecology and Environmental Change: An Applied Approach to Manage Prosopis-Encroached Landscapes in Namibia.* PhD thesis, Faculty of Humanities and Social Sciences (Geography Department), University of Namibia, Windhoek, Namibia.

Prosopis yields very attractive hardwood to make rough furniture with (e.g. table tops, pillar casings). There is one factory near Leonardville that uses it, while charcoal is made of it in the Olifants river in southern Namibia.

Other alien woody plants that occur in Namibia and have the potential to invade larger areas are the mimosine-containing "wonder tree" *Leucaena leucocephala,* widely planted on farms but not invasive on a large scale, and *Lantana camara* hybrids that seem to escape no further than from the urban garden into the suburbs. Various cacti (*Opuntia*) species readily become invasive, but can hardly be considered "woody". Apart from *Prosopis,* alien woody plants seem not to become invasive in Namibia easily.

3.2 Extent of de-bushing activities in Namibia

De-bushing and bush control activities on commercial farms and in communal areas of Namibia is not regulated by any specific law, although it should be guided by the principles of sustainable rangeland management as expounded in the National Rangeland Management Policy & Strategy of 2012. De Klerk (2004) made many sensible suggestions regarding regulating such activities in chapter 9 of his book. In the farming community and charcoal industry, reference is commonly made to dormant "Bush Encroachment Management Regulations", but no-one has details thereof. In the MAWF, no-one in Forestry, Law Enforcement or Pasture Research has these regulations, currently or historically. Most probably, such regulations were proposed many years ago but never got off the ground. As far as farmers are concerned, their bush control activities are not subject to the Environmental Management Act no. 7 of 2007[13] unless an area 20 ha or more in extent is clear-cut to create a crop field (for which approval from the Directorate of Forestry is also required) or an area is especially sensitive environmentally.

Just five years ago, it was cheaper in most areas to buy a new hectare of farm land than to de-bush an existing hectare. Farmers had little direct (short-term) economic incentive to de-bush. Lately, farm prices have escalated faster than de-bushing costs and it is (again) cheaper to control bush on your existing farm than to buy new/additional farm land. The cost structure of de-bushing has not changed materially from that provided in the local assessment study of 2012 (App. IV), although inflation at about 6% p.a. has increased the stated costs by 10-15% across the board. It is the price of land that has increased much faster than inflation.

Of course, over the longer term, it should always be more profitable to increase productivity on your own farm than to exchange a bush-encroached for an open farm. For farmers (in particular livestock ranchers) to take a long-term view requires a good understanding of the eco-biological processes underlying livestock production and a secure socio-political environment that promotes investment because it secures long-term returns on investments. The former could be promoted by improved training of and advisory services to farmers; the latter depends very much on the political climate in the country. Training in bush control could be presented at two levels, for the land owner/manager and for the farm worker:

- Higher-level training (NQA level 4-5) on the principles of bush control and wood use for farm/reserve owners and managers, and

13 : MINISTRY OF ENVIRONMENT AND TOURISM, 2007. Guide to the Environmental Management Act No. 7 of 2007. Ministry of Environment & Tourism, Windhoek, Namibia.

- Hands-on, practical training (NQA level 2) in various bush control methods (e.g. chemical) and wood use for farm workers and field staff.

To better determine the historical and current extent of bush control in Namibia, the baseline study investigated the sale of arboricides (chemicals that kill plants, specifically woody plants) and asked farmers directly how much bush they control, how and why (rapid survey detailed in chapter 2: Methodology).

3.2.1 Sales of arboricide

One measure of the extent of de-bushing in Namibia is the sale of arboricides by agricultural retailers (Agra, Ltd., KaapAgri) and by specialist bush control services (Meat Board of Namibia, Odusa Trading, Alex McDonald). Most aerial spraying services supply their own arboricides and do not make use of arboricides bought at agricultural retailers or the MBN. Exploring this avenue does not capture non-chemical means of bush control and thus underestimates the area on which bush was controlled.

Picture 3: Soil-applied arboricides a commonly used chemical bush control method

The large South African-owned input supplier informed that their arboricide sales have slowed recently due to the competition of cheap Chinese arboricides distributed at cost by the MBN. In 2014, they sold 11 different arboricides, containing a number of active ingredients and offered in a variety of formulations; as liquid or powder-based sprays or in pelleted format. Recent sales of arboricides by the MBN are as follows:

Table 3: Sales of arboricides by MBN

Year	Liquids sold (*l*)	Treatable area	Solids sold (kg)	Treatable area
2012	2,600	at 2 *l*/ha = 1,300 ha	4,220	at 3 kg/ha = 1,407 ha
2013	2,040	1,020 ha	2,225	742 ha
2014 (extra-polated)	3,155	1,576 ha	2,350	783 ha
3-yr average	**2,598**	**1,299 ha**	**2,931**	**977 ha**

It is highly unlikely that every hectare of farmland was treated equally with these arboricides and more likely that they were applied selectively over an area at least twice the calculated size, i.e. approx. 5,000 ha/year. If the customer had wanted to treat each hectare uniformly, s/he would have applied the arboricide from the air.

The largest local cooperative agricultural input supplier (recently converted into a private company) refused to divulge relevant trade data. Industry insiders reckon that it sells a similar amount of arboricides as its main, South African owned competitor, i.e. sufficient to treat another 5,000 ha per year.

This is little compared to what the main supplier of arboricides, the MBN, sells each year. The MBN started to sell Chinese-made arboricides at cost in 2007 and sales have since been as follows:

Table 4: Chinese-made arborcides cost and sales

Year	Liquids sold (*l*)	Treatable area	Solids sold (kg)	Treatable area
2007	24,500	at 2 *l*/ha = 12,250 ha	0	0
2008	19,620	9,810 ha	0	0
2009	13,500	6,750 ha	4,500	at 3 kg/ha = 1,500 ha
2010	20,990	10,495 ha	9,800	3,300 ha
2011	22,500	11,250 ha	19,700	6,600 ha
2012	20,480	10,250 ha	25,200	8,400 ha
2013	12,920	6,500 ha	19,800	6,600 ha
2014 (extra-polated)	14,980	7,500 ha	9,000	3,000 ha
Average	**18,686**	**9,350 ha**	**14,670**	**4,900 ha**

On average, the arboricides sold by the MBN are sufficient to treat 14,250 ha uniformly or nearly 30,000 ha selectively, each year. They offer three different products containing tebuthiurone, bromacil or a mixture of the two.

Odussa Trading, owned by Dawid Botha, started offering aerial and ground-based arboricide spraying services in 2008. Aerial spraying is largely unselective while ground-based spraying is much more selective. So far, Odussa has treated the following areas:

Table 5: Treated areas using aerial and ground based spraying

Year	Area sprayed aerially	Area sprayed on ground
2008	22,071 ha	4,010 ha
2009	23,000 ha	5,060 ha
2010	22,000 ha	4,070 ha
2011	20,130 ha	5,170 ha
2012	18,900 ha	5,510 ha
2013	21,500 ha	6,100 ha
Average	**21,267 ha**	**4,987 ha**

Odussa uses only 20% tebuthiurone at 4-5 kg/ha; higher if the soil contains more than 6% clay or the problem species is *Dichrostachys cinerea.* Their statistics could not be broken down into magisterial districts, but most spraying operations are located north of Okahandja.

Alex McDonald's aerial spraying service has only been active since 2013. He has treated 8,000 ha in 2013 and 18,900 ha (extrapolated from January-July sales) in 2014 from the air. He uses tebuthiurone only, at about 5 kg/ha.

Picture 4: Small planes used to broadcast arboricides from air, for mass bush control

The arboricides sold by retailers and bush control specialists are enough to treat 64,000 ha chemically each year but were probably applied to nearly 84,000 ha in 2013/14. Some of these hectares might have been treated chemically earlier, i.e. they were treated a second time as part of aftercare. This estimate excludes non-chemical methods of bush control, e.g. manual, mechanical or biological control.

According to the owner of Odussa Trading, aerial application of tebuthiurone-containing arboricides in pellet format is the most effective method against most encroaching bush species. Most *Acacia* species are easy to kill off from the air. Namibia's major encroaching bush species, *Acacia mellifera* has a soft-coated seed and is readily controlled by aerial spraying. Some encroaching bush species with hard-coated seeds such as *Acacia luederitzii* especially and *Acacia reficiens* to a lesser extent grow back rapidly because their hard-coated seeds survive the chemical attack. The cost of controlling these species by aerial application seldom exceeds N$1,000/ha because application rates, even on loamy soil (which requires higher application of arboricides) seldom need to be as high as 8 kg/ha. Most often it is in the range of 3-6 kg/ha, costing N$400-700/ha.

The real challenge to aerial application of arboricides is *Dichrostachys cinerea,* an encroaching bush species with hard-coated seeds that is able to re-grow from root suckers. Even at a high application rate of 12 kg arboricide/ha, which is double the application rate recommended on the product label and is prohibitively expensive at close to N$1,500/ha, this species often survives aerial chemical control either by re-sprouting from underground organs or re-growing from seed. The best would be to have a series of successive aerial chemical control events, but few farmers can afford such prohibitively expensive control programmes.

Generally, companies involved in aerial spraying are aware of the negative ecological effects of unselective chemical control from the air and try to minimise unintended kill-off. How effectively, would have to be investigated. Negative examples of “aerial overkill” abound to such an extent that some rangeland experts are in favour of a blanket ban on the aerial application of arboricide. In mitigation, some aerial sprayers have implemented a more selective ground-based application programme in response to farmer demand. It is hoped that this approach will also be more effective and affordable to control *Dichrostachys cinerea.*

Picture 5: ''Overkill'' of useful woody plants (e.g tall trees)

The Registrar of Agro-Chemicals and Animal Feedstuffs in the office of the MAWF operates under the vastly outdated Fertilizers, Farm Feeds, Agricultural Remedies and Stock Remedies Act no.36 of 1947 and has to approve all agro-chemicals that come into the country. No permission to import is granted unless the product is approved by the Registrar’s office. Since the office does not have intent or capacity to conduct registration tests and product evaluation itself, it mostly accepts the registration of products in their country of origin. Especially South African products are easily registered for use in Namibia. Unfortunately, the Registrar’s office keeps only qualitative records of what products were approved (“registered”) and not how much was imported, for what purpose, in what year and by whom. Even products discontinued or banned long ago are still on its list of “registered agro-chemicals”. Thus, an obvious manner to collect valuable information is not utilised and the quality of existing information is too poor for good decision-making by managers. This is an area where the De-Bushing Programme could improve capacity fairly easily and with great benefit.

3.2.2 On-farm bush control

The most direct way to quantify the extent of bush control on farms is to ask farmers directly by means of a questionnaire-based rapid survey but the response to such a direct approach is usually not satisfying. At least this method does not exclude any method of bush control, like an assessment of arboricide sales. As expected, the response to the questionnaire-based rapid survey was underwhelming: 81 farmers on 532,863 ha responded; a sample size that is poorly representative of the larger farming community as a whole. All responses were of commercial farmers. Nine responses (11.1%) were of “nil returns” indicating that these farmers did not control bush on their farms of 67,884

ha, while 72 farmers (88.9%) indicated that they controlled bush in some way on their farms of 464,979 ha. As it can safely be assumed that more than 10% of Namibia's farmers do not engage in any bush control, the survey seems to have attracted proportionally more responses from "control" farmers. This is good as it throws more light on the activity under investigation, thus negating some of the limitations of the low response rate. Of the farmers who did engage in bush control, 47 responses were classified arbitrarily as "small", meaning that bush was controlled on less than 1,000 ha and 25 responses were classified as "big", with bush control on more than 1,000 ha.

In total, 72 farmers farming on 464,979 ha controlled bush on 82,447 ha (= 17.7%) in the last three decades. "Big" operators who did a lot of bush control treated 67,535 ha on 176,859 ha of farmland (38.2% of farm land) while "small" operators who did little bush control treated 14,912 ha on 288,120 ha of farmland (5.2% of farm land). Farmers who decided to engage bush on a large scale tended to control seven times more bush than farmers who controlled it on a relatively small scale. This indicates that relatively few farmers have the conviction and/or means to control bush in a "big" way, on thousands of hectares.

Of those magisterial districts with a reasonable number of respondents, Otjiwarongo farmers treated the largest proportion of their farmland (39.7% of area), followed by farmers in Okahandja (27.8%), Windhoek (16.8%), Gobabis (15.8%) and Grootfontein districts (12.4%). Tsumeb, Outjo, Mariental and Aranos districts also had high land treatment proportions, but low respondent numbers. Bush control patterns thus appear to follow bush encroachment patterns, increasing in a northerly direction.

Over all respondents, chemical means of bush control was applied on two-thirds of the area of farmland treated whereas manual and mechanical control, charcoal-making and fire together were only applied to one-third of the area treated:

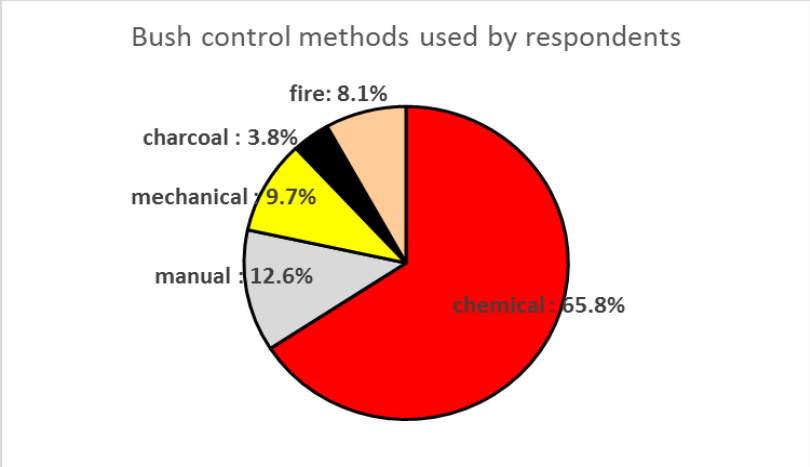

Chart 3: Bush control methods used

Chemical means of bush control was applied to 54,125 ha and was by far the most popular method of bush control. 54.6% of the area of farm land treated by "small" and 68.1% of the area treated by "big" operators against bush involved chemical control; with two-thirds being applied selectively by hand and one-third unselectively from the air. Aerial spraying would have been performed predominantly by the specialists mentioned in the previous section. About 87% of all chemical applications (manual and aerial) were done since the year 2000, with only 10 records predating the second millennium. All operators

who applied aerial chemical control reported that it was applied unselectively to the landscape treated, while 85% said that manual chemical control was performed selectively.

As far as manual chemical bush control is concerned, it is becoming more popular for women to apply the chemicals as they are generally more reliable and accurate than men, but very few farmers could actually quantify the gender ratio. In contrast, manual, semi-mechanised and mechanised control methods are still largely (nearly exclusively) executed by men.

The second-most commonly used method of bush control, by some distance, was manual control. 11.4% of the farmland area treated by "small" and 12.8% of the area treated by "big" operators used manual means of chopping (84%) or stem-burning (16%) to control bush. The low incidence of stem-burning confirms anecdotal observations that it's not used often these days. Stem-burning was popular in the 1990's and appears to be going out of fashion. Most every respondent used these manual methods of bush control selectively.

Then follow other, less often used methods of bush control. Only 6.0% of "small" and 10.4% of "big" operators use mechanical means of bush control, primarily the bulldozer. Amongst both operator classes, the use of bulldozers seems to be on the increase again after waning in the 1990's and early 2000's. Interestingly enough, nearly all operators, irrespective of the size of their operation, say they applied the bulldozer selectively. Many mention that they are not happy with the bulldozer as it stimulates re-growth (presumably of root-sucker species such as *Dichrostachys cinerea*), disturbs the soil and is very expensive. Only "small" operators registered the use of tractor-mounted equipment such as the "Bosvark" (circular saw blade) to control bush; "big" operators did not seem to use this kind of machine.

Nearly 8.2% of the area treated by "big" and 7.7% of the area treated by "small" operators was subjected to fire to control bush. 80% of fires were lit on purpose as part of a controlled burning programme. This is surprising given the anecdotal evidence of fire-aversion amongst Namibia's farmers, but with positive effects on bush density.

In this survey, only 0.7% of the area treated by "small" and 4.4% of the area treated by "big" respondents was used to make charcoal. Considering that a lot of charcoal is made in Namibia it is evident that farmers don't see charcoal-making as a means to control bush. This reflects poorly on the reputation of the charcoal industry.

It is interesting to compare the sale of arboricides with the farmers' preferred methods of controlling bush. In the previous section, it was estimated that enough arboricides were sold in Namibia in the year 2013/14 to control bush chemically on nearly 84,000 hectares of farm land. In the rapid survey, farmers indicated that they treated 54,125 ha chemically over the years and that 65.8% of the farm land area subjected to bush control involved chemical means. If the same proportionality is true for the year 2013/14, then a total of 127,660 ha of commercial farm land was treated against bush (all methods) in the year 2013/14, of which 43,660 ha would have been treated by non-chemical methods. Even though the treated area is only 0.16% of the total land surface area of Namibia (823,680 km^2), or 0.19% of the area exposed to agriculture and non-State conservation (roughly 18% of the country is desert or state-protected conservation area)[14], it is a huge effort based predominantly on the actions of individual land

14 : MENDELSOHN, J., A. JARVIS, C. ROBERTS & T. ROBERTSON, 2003. *Atlas of Namibia* (2nd impression). David Philip Publishers, Cape Town South Africa.

users and it is repeated year after year (possibly), i.e. it is cumulative. However, responses to the rapid survey also show that re-growth of controlled bush may be rapid in the absence of aftercare, i.e. the benefits of initial bush control (by whatever method) may not be as long-lasting as hoped for.

Returning to the rapid farmer survey, 64% of "small" operators did not apply aftercare after initial bush control. Amongst "big" operators, only 31% did not apply aftercare. No wonder only 42% of "small" operators are satisfied with the results of their bush control, whereas 63% of "big" operators are satisfied with their bush control method. The most common complaint is "that the bush simply grows back" from coppice or seed. This should be obvious because no bush control is complete without aftercare! This information points towards insufficient knowledge of proper bush control methodology or insufficient means to carry through with aftercare, especially amongst "small" operators, who invest a lot of money into initial control but then waste it by not following up afterwards. Of those respondents who did apply aftercare, 68% did so within 1-6 years after initial control, while 32% only did so after 6-10 years.

The questionnaire asked respondents if they thought they had *more* grass after bush control. 83% of "big" and 89% of "small" operators answered in the affirmative. But when it came to *better* grass after bush control, only 62% of "big" and 57% of "small" operators answered in the affirmative. This reflects a relatively recent realisation that bush control is only a first step in rangeland rehabilitation, but that long-term recovery of the grazing capacity requires active rehabilitation of the grass sward as well. Since this is a new and under-researched topic, the De-Bushing Programme might focus some interventions on the repair of the grass sward.

Less than half of all respondents indicated that they harvested encroacher wood and added value to it after bush control. Only 44% of "small" and 36% of "big" operators used the wood of controlled bush, predominantly as firewood (sold and domestic), underlining the perception that Namibian farmers control bush to improve their grazing, not to utilise its inherent value. A huge public information and re-orientation effort thus awaits the De-Bushing Programme.

Respondents were also asked what would motivate them to apply more bush control, in order of importance. By far the most responses (76%) of "small" operators rated various forms of financial assistance as most important; be it cheaper arboricides, subsidised loans, arboricides and labour or general financial incentives. A few mentioned the training of workers to increase efficiency and make supervision easier, more mechanised and easier methods of bush control and improved visibility on farmland (for security and control of poaching). Ecological and environmental motivations were of secondary importance, along with professional advice, availability of professional application or control teams, organised fire-fighting, political stability in the country, cheaper diesel, value addition to encroacher wood and reduced soil erosion. Responses of "big" operators were largely similar, but they also included more conducive labour laws, improved rangeland productivity and improved visibility (for trophy hunting) as most important. Lesser motivations included the increased use of controlled fires and training in the use of fire, ease of obtaining charcoal harvesting permits, a developed market for wood products and higher cattle prices. These responses clearly identify the range of issues that motivates farmers to do more bush control.

The National Youth Service (NYS) is de-bushing the experimental farms and extension stations of MAWF in a labour-intensive manner to create employment for Namibia's youth and rehabilitate the range.

Their de-bushing activities inform the strategic plan of MAWF[15], which provides for de-bushing an additional 13,300 ha on top of the existing 6,700 ha already de-bushed (claimed, not verified) until 2016/17. De-bushing of a government farm is initiated by its manager who also determines the process, area and base price. This NYS activity could be a model to up-scale and link with targeted training of SME workers and wood procurement opportunities, as well as with NamPower, who is looking for a biomass torrefection partner to test-fire Van Eck power station.

The MAWF is also tasked with implementing or overseeing some of the objectives of the 4th National Development Plan (NDP4) for the period 2013/14 to 2016/17. To achieve the NDP goal of economic growth, employment creation and increasing income, the Directorate of Forestry has set itself a target of de-bushing 8 million hectares by 2016/17, estimating that N$1.7 billion will be required to implement this strategic execution plan (SEP). Both plans, NDP4 and SEP are mute on where the resources needed to achieve these goals would come from, how this plan will be implemented and by whom. Since Forestry did not include these larger goals in its own Strategic Plan of 2014 and did not specify an implementation strategy, it is reasonable to assume that implementation will take longer than the planning period of NDP4, especially considering the enormity of the task.

Although communal farmers were also exposed to the questionnaire described earlier via their farmers' union the NNFU, they did not respond. The likely reason is that bush control in communal areas hardly exists and will have to operate differently than in commercial farming areas. Collective responsibility for the natural rangeland and lack of individual title to farmland makes it irrational for an individual farmer or a small community to rehabilitate their rangeland, starting with bush control. Other pastoralists would move their livestock into the rehabilitated area without asking permission or exposing themselves to penalty and erode the benefit to the one who rehabilitated. Bush control in communal areas would have to be organised on a community basis, using existing or creating new institutions that have the authority to delineate an area, restrict access and organise management and utilisation. Such institutions may be rural cooperatives as created by the Community-Based Rangeland and Livestock Management (CBRLM) programme of the MCA-N in the northern communal areas, or an authoritative farmers' association or village committee. Creating such entities probably requires external start-up funding and can profitably be linked to wood processing industries and markets. Wood extraction and processing should be labour-intensive to reduce rural unemployment. Importantly, it is highly likely that Government will only subsidise bush control if it is applied equally across the country. In addition to this major structural difference, encroacher bush in communal areas often serves as a drought reserve and a strategic fodder resource of the last resort. Also, wood in densely populated communal areas has many more uses than in sparsely populated commercial areas, e.g. for domestic energy and building material. Therefore, bush thinning would have to be approached much more judiciously than in commercial farming areas.

From the above, it is clear that more farmers would control more bush if they were better informed and advised; which will be discussed in the following chapters. In Namibia's farming community are many success stories of bush control, even of problematic species such as *Dichrostachys cinerea* and *Rhigozum trichotomum.* The De-Bushing Programme should investigate some of these case studies in depth, possibly adding some on-farm trials to contribute to best practices of encroacher bush control, extraction and utilisation to inform the envisaged advisory system. In principle, manual bush control methods are best able to extract wood for further use but all methods except fire can achieve this goal if

15 : MINISTRY OF AGRICULTURE, WATER AND FORESTRY, 2014. *Strategic Plan 2012/12 – 2016/17.* Occasional report p. 10, Ministry of Agriculture, Water and Forestry, Windhoek, Namibia.

appropriately adapted. The perception that arboricide residues[16] may affect the quality of Namibian meat has also not been researched despite repeated calls for this matter to be addressed urgently. Generally, the De-Bushing Programme is advised to initiate action on some of the components of the bush encroachment management and containment strategy described by De Klerk (2004) in chapter 9 of his book on bush encroachment in Namibia.

16 : The residues of arboricides' active ingredients in biological materials (e.g. soil, plants, water) have been much-researched internationally and also in Namibia (Honsbein's MeatCo study in 2012), but not the possible residues of arboricides (i.e. active ingredient plus adjuvants and additives) in meat and milk.

4. Outcome A: Capacity development and framework conditions for de-bushing

The first major outcome of the De-Bushing Programme is to enhance the capacity to control encroacher bush ("de-bush") by improving the framework within which this happens, i.e. the regulatory and institutional framework. Aspects of importance in this regard are to coordinate the often fragmented and *ad hoc* attempts to build capacity, amend the regulatory framework to suit the purposes of bush control and encroacher wood use explicitly and not as an afterthought of general environmental or forestry management, expand the incentives to control bush and add value to encroacher wood and to suggest a sectoral monitoring and evaluation system to record progress.

4.1 Coordinating functions

Various institutions have tried over the years to coordinate bush control and bush utilisation activities. Namibia's three agricultural unions, being the Namibia Agricultural Union (NAU) aimed mainly at commercial farmers but slowly evolving to represent the interests of all farmers and with diverse associations affiliated to it (e.g. the NCPA), the Namibia National Farmers' Union (NNFU) for communal farmers and the Namibia Emerging Commercial Farmers' Union (NECFU) for resettlement farmers all are trying their best to coordinate activities in a field fragmented by political, social and special interests.

During the planning phase of the De-Bushing Programme, the MeatCo Foundation launched its Bush-to-Land-to-Meat Project, which supported de-bushing on farms to raise beef production and linked it to its Ekwatho Scheme[17]. One of its important outcomes is that farmers who de-bush by taking out loans, find it easier to service the loans by joining MeatCo's Ekwatho Scheme; discussed earlier.

Over the last decade, on-and-off efforts to coordinate rangeland rehabilitation and bush control eventually culminated in a voluntary steering committee chaired by the Director of Forestry in the MAWF, which compiled the National Rangeland Management Policy (Part I) & Strategy (Part II) (NRMP&S)[18]. The NRMP&S was signed by Cabinet and became a legal document in 2012. In Part II (the Strategy), chapter 4, the strategy spells out the institutional framework required for implementing the NRMP, assigning leadership and roles and responsibilities in communal, commercial, resettlement and national protected areas. The voluntary steering committee that had initiated this process re-constituted itself to become the Namibian Rangeland & Bush Encroachment Forum (NR&BEF; incorrectly called the "Namibian Rangeland Forum" in the NRMP&S) with its own terms of reference. The NR&BEF was subsequently tasked by the NRMP&S with annual work planning, budgeting, monitoring, and evaluation and reporting to the line ministry, the MAWF and drew up a work plan and budget late in 2013. The NR&BEF is not to be confused with the NRF, which is a purely voluntary interest group (or think tank) that continues to meet informally once a year to reflect on matters of sustainable rangeland management but has sparked numerous important initiatives over the years.

As always, funding these planned rangeland coordination activities is a problem. That's why the NAU took the initiative to apply for, and was recently granted funding under the 10th European Development Fund's call for climate change proposals. Under the NAU grant, the consultative NR&BEF and its executive arm the Rangeland Advisory Forum transform into a steering committee to launch and

17 : ANONYMOUS, 2011. *Strategic Planning for the Bush-to-Land-to-Meat (BLM) Project.* Minutes of meeting 25 November 2011, MeatCo Foundation, Windhoek, Namibia.
18 : MINISTRY OF AGRICULTURE, WATER AND FORESTRY, 2012. *Ibid*.

supervise the full-time Rangeland Coordination Unit (RCU)[19], the new executive organ that has to coordinate all rangeland-related activities, including bush control, under the guidance of the NRMP&S. Specifically, the RCU is tasked with integrated planning and coordinated implementation of the NRMP&S, recording best practices of sustainable rangeland management, utilisation and rehabilitation, periodic rangeland audits and to lobby for and implement incentives for sustainable rangeland management. Wood extraction for value addition has not been amongst its briefs but could easily be added to its agenda.

It is highly recommended that the De-Bushing Programme try and achieve one of its main objectives, viz. creating a single coordinating unit to guide all de-bushing and wood value addition activities, in close cooperation with the RCU and under the umbrella of the NRMP&S.

4.2 Regulatory framework

In Namibia, a plethora of Acts and Policies apply to environmental management generally and to rangeland management and de-bushing in particular. These are best summarised in the 2012 NRMP&S document, part I: the Policy, chapter 4 (Annexure A: The National Policy Environment). Many of the Acts and Policies that apply specifically to the bush control sector of extensive agriculture have also been detailed by Diekmann & Muduva (2010) and Odendaal (2012)[20]. In these excellent revues, the historic process of regulating the charcoal industry, bush encroachment and rangeland management are described and the streamlining of often conflicting regulations, strengthening and harmonising of the legal framework and addressing of grey areas (uncertainties) is proposed. This baseline report cannot add to that work other than to point out that there was a legal addition since then as many of the clauses of the Environmental Management Act, no. 7 of 2007[21] were only activated in 2012 and some remain inactive even today, greatly adding to the confusion of what applies to whom, when and how. Importantly, the long-recommended Namibia Woodland Management Council has still not been promulgated (and it probably should not resort under "Forestry" if it is to address bush control on farms).

Some of the conclusions and recommendations of Odendaal (2012) are worth repeating here:

- The responsibility of managing the land has been devolved from the State to the land user. The implication is that the land user stands pretty much alone, can do good/bad things as s/he likes and will not receive much support or encouragement from the State.
- There are no legal incentives to manage bush encroachment and reverse its negative impacts.
- Different Acts take different stands on financial incentives such as the payment of subsidies to land users and producers (e.g. Soil Conservation Act in favour, National Agricultural Policy against).
- Any bush encroachment management policy should encourage a wood industry that utilises encroacher wood. This requires good cooperation between various ministries, especially MAWF, MET, MLR and importantly also the MTI to assist with industry establishment and structuring.
- In the MAWF, the Directorate of Extension and Engineering Services (DEES)[22] rather than DoF should spearhead a bush encroachment management policy.

19 : SCHNEIDER, M., 2014. Creation of a coordination unit for the speedy implementation of the National Rangeland Management Policy and Strategy (NRMPS). *Proceedings,* 18th Namibian Rangelands Forum p. 4, Gobabis, Namibia.
20 : ODENDAAL, W., 2012. *De-bushing Support in Namibia.* Consultant's report, Legal Assistance Centre, Windhoek, Namibia.
21 : MINISTRY OF ENVIRONMENT AND TOURISM, 2007. *Ibid.*
22 : Since being re-structured in mid-2014, DEES is now known as the Directorate of Agricultural production, Extension and Engineering Services.

- The NRMP&S should have included a Bush Encroachment Management Policy but does not. Should a separate policy be devised or the NRMP&S amended to include this aspect? Similarly, the NRMP&S is weak on the methods of rangeland rehabilitation.
- A Woodland Management Council (WMC) along the lines of other statuary boards like the Namibia Agronomic Board is needed to facilitate the regulatory, financial and administrative responsibilities, marketing and market development associated with a wood industry. A WMC should include bush control and wood use.
- The charcoal industry has matured and should be better structured, strengthened and placed on a sound regulatory, financial and administrative footing with strong FSC oversight.
- Labour-intensive, non-chemical methods of bush control should be encouraged.
- Bush control and encroacher wood utilisation should lead to SME development.
- Controlled fires should be integrated into any bush encroachment management plan, which might mean that some Acts and Policies need to be amended accordingly.
- The absence of arboricide residues in food (e.g. meat and milk) should be ascertained.
- An integrated information and management system for the bush industry should be developed.
- Proper bush control and restoration of the land's grazing capacity holds advantages for Namibia's land reform programme.
- Individual and group tenure rights in communal areas need to be strengthened along the lines of communal area conservancies, community forests and communal cooperatives to facilitate proper rangeland management and encroacher bush control, although tenure rights *per se* are no guarantee of the sustainable management of natural resources.

In commercial farming areas, de-bushing activities on title deed farms are not regulated by any Act of the Namibian Parliament, unless the farm is located in an area that is very sensitive environmentally. The Forest Act of 2001 states only that it is prohibited to clear-cut more than 30 hectares of land that has predominantly woody vegetation. The Environmental Management Act of 2007 triggers an environmental impact assessment if more than 20 hectares of land are cleared of woody vegetation or land is re-zoned. However, these activities clearly apply to the establishment of crop fields, not to routine rangeland management such as bush control.

In the MAWF, responsibility with bush control lies with the Directorate of Forestry. In the Ministry's strategic plan, DoF indicates that it wants to triple the hectares de-bushed from the current (2012/13) 6,700 ha to 20,000 ha by 2016/17 under the "Forest Resource Management" project (Deputy Director Forest Management: Ms. Anneli Shishome). It is not yet clear what particular activities will be launched as part of this plan. To have such an important rangeland management issue resort under "forest management" is a serious anomaly that can only cause confusion and inaction. Possibly, this responsibility should be moved to DEES or to a new body such as the RCU mentioned in the previous section, a Woodland/Bush Encroachment Management Council or similar.

The De-Bushing Programme could do well to reduce confusion and friction caused by various duplicitous legal documents by proposing amendments and compiling a comprehensible guide for farmers on which Acts and Policies apply to rangeland management, including the management of bush encroachment, on the farm. It should also give serious thought to whom/what institution should house the De-Bushing Programme or its successor and lead the quest to find, constitute and equip an appropriate institutional home for bush control and wood value addition activities in future.

4.3 Incentive schemes

In one of the NRMP&S preparatory documents, it is stated eloquently that "… in the current policy environment there are private market-based incentives for good rangeland management. Investing in sound rangeland management practices can increase stocking rates and also increase profitability for rangeland users in both commercial and communal land. It also increases returns to the national economy making it economically efficient. These inherent incentives for the rangeland user, and for the nation as a whole, should form the basis of any future interventions by government and any other stakeholders in the management of rangelands. The aim should be to strengthen and consolidate these existing market-based incentives."[23] Principally, bush control and wood use should be their own incentives, without the need for special incentives other than those available to all other industries: infant industry protection measures and the enhanced availability of capital to expand the budding industry. What makes bush control somewhat unique as an industry is that it is operated by thousands of small businesses (farmers) that have to apply it to a huge area (basically a whole country). This may necessitate some special support measures.

Mr. Nico de Klerk published a very detailed bush containment strategy in 2009[24] as a downstream result of his book on bush encroachment in Namibia, linking it to Namibia's agricultural policy and the future rangeland management policy. It has since been overtaken by the NRMP&S but a very relevant aspect are his proposals on incentives for farmers to improve rangeland, including controlling encroacher bush. He identified the major impediments to on-farm bush control as:

- Lack of sufficient capital,
- High costs associated with bush control,
- Political uncertainty that encourages short-term thinking and
- Legislative barriers, especially in terms of inflexible and job-stifling labour laws.

He suggested various incentives to encourage farmers to start bush control, implement sustainable rangeland management and utilise harvested encroacher wood, such as:

- Direct financial interventions by means of subsidies, soft loans, food-for-work and similar job-creation programmes,
- Government support for the creation of a wood utilisation industry,
- Various demand-driven intensive training and mentoring programmes,
- Implementing agents from the private sector, and
- Applied research based on proven, on-farm success.

However, GRN is in principle opposed to paying subsidies to the agricultural sector and only the out-dated Soil Conservation Act actually provides for it. To this list could be added the following:

- Payment to land users for preserving ecosystem services (e.g. water yield in catchment areas, preservation of biodiversity and landscape integrity etc.), and
- Discounts on land tax rates for farmers who apply proven and quantifiable sustainable natural resource management methods.

De Klerk further emphasised that land reform and tenure security cannot be uncoupled from bush control and sustainable rangeland management. His proposals formed the basis of the NAU's submission

23 : HUMAVINDU, M., J. BARNES, C.A. NOTT, N. DE KLERK, A.K. KRUGER, 2011. *Economic Valuation of Good Rangeland Management and Incentives for Efficient Implementation for the National Rangeland Strategy*. CPP consultant's report, Ministry of Environment & Tourism, Windhoek, Namibia.

24 : DE KLERK, J.N., 2012. Incentives for farmers to improve rangeland. *Proceedings* 16th Namibian Rangelands Forum p. 7, Windhoek, Namibia.

to AgriBank and Cabinet[25] in 2011 proposing financial support to farmers who counter encroacher bush, which has had no outcome thus far.

4.3.1 AgriBank

Financial incentives offered to farmers to promote bush control are mainly in the form of "soft" (favourable) loans. The biggest lender to the agricultural sector is the AgriBank of Namibia. Amongst its long-term financing products are loans for deforestation of dry lands and for bush control by aerial spraying or any other method that includes labour, with a 15 year term and at 8% interest. Normally, the loan is guaranteed by investments or a bond over the farmland but urban property also qualifies as loan security collateral. This enables tenure-less communal farmers to also benefit from the bush control loan scheme. Beneficiaries can be full- or part-time farmers, must provide a business plan, details of the area to be treated and a quotation of expected costs. Bank officials were quick to point out that all types of bush control qualify although loans have thus far only been given for chemical control methods.

At 2014 beef prices, it was calculated that a loan from AgriBank to control bush (15 years' term and 8% interest p.a.) at N$315/ha can be paid off by the profit generated by MeatCo-owned cattle. Annual re-payments of N$37/ha are covered by the extra profit of N$53/ha earned by MeatCo-earned cattle[26], which producers can buy under MeatCo's "Ekwatho" scheme with a bank loan that gets deducted from the final sales price, underwritten by MeatCo. Ekwatho clients also get technical assistance and mentoring to raise the "loan" cattle successfully to slaughter.

4.3.2 Commercial banks

Most of Namibia's four large commercial banks provide loans especially for farmers but as far as could be ascertained, FNB is the only commercial bank to offer loans specifically to control encroacher bush; and preferably by chemical means. FNB Agri Division offers a 10 year loan at prime interest rate (currently 9.25%) with capital repayment only in year 4 to 10 of the repayment period. The bank reckons that it takes a farmer about 3 years to start reaping financial benefits from bush control and is thus prepared to finance the first 3 years' interest itself. To qualify for a loan for chemical bush control, each applicant will be evaluated technically on – amongst others - a cost/benefit analysis, estimated number and size of target woody species to be treated, an aftercare programme to keep the savanna in the post-treatment condition and a certificate that the intended arboricide is environmentally friendly. The average loan size is N$500,000 but the number of current clients was not divulged. It was pointed out that most loans are given for chemical bush control but other bush control methods also qualify.

FNB has calculated that a subsidy of N$5 million to the bank would enable it to give out N$100 million more in loans at lower interest rates (half-prime , i.e. 4.75%), thus making it cheaper to borrow money to control encroacher bush. Considering that 66% of the farmers who responded to the rapid survey indicated that they would be motivated by financial incentives, the De-Bushing Programme might therefore consider boosting this and similar existing financial incentives schemes or to expand their impact, especially as far as loans for manual, labour-intensive methods of bush control are concerned.

25 : NAMIBIA AGRICULTURAL UNION, 2009. *Financial Support to Farmers in Combating Invader Bush.* Memorandum for consideration by AgriBank and Cabinet, Namibia Agricultural Union, Windhoek, Namibia.
26: ZENSI, 2014. *Ibid.*

As a matter of interest, how much would it cost a de-bushing loan scheme to de-bush the entire Namibia (working on the commonly-accepted notion that "only" 26 million hectares of Namibia are bush-encroached)? FNB calculated that to give out loans to treat the whole bush-encroached area at a subsidised rate of 4.25% would require N$16 billion in total of which N$800 million would have to be recovered as a subsidy[27]. Comparatively speaking, this is financially equivalent to Namibia's ambitious, N$14.5 billion Targeted Intervention Programme for Employment and Economic Growth (TIPEEG) launched in 2011/12, would have similar benefits to the national economy and probably create more permanent jobs than the 104,000 that TIPEEG promised, but has so far not delivered. However, Government and donors are unlikely to subsidise a scheme of such extent. It would be better for any bush control incentives to be integrated into wider incentives for sustainable rangeland management and rangeland rehabilitation, which would probably enjoy more GRN support.

4.4 A sectoral monitoring and evaluation system

Just like a project needs to be monitored and evaluated during its implementation phase, the progress that an economic sector makes (possibly due to project assistance) should also be monitored and evaluated. Up to now, there has been no systematic, planned monitoring of bush control and wood use in the rangeland-based agricultural sector of Namibia.

Who or what institution would in future monitor the progress of the country to de-bush and rehabilitate its degraded rangeland? As things stand in mid-2014, this near-impossible task obviously belongs with the Directorate of Forestry in the line ministry responsible for agriculture in Namibia, but this Directorate is just as obviously already overburdened by its current de-bushing responsibilities. However, the soon to be formed, NAU-housed, EDF10-funded Rangeland Coordination Unit (RCU) is the ideal vehicle for such a task. It already plans to compile a baseline audit of rangeland condition and occasional (bi-annual?) follow-up audits. Since bush control is such an integral part of sustainable rangeland management, it would depend on the De-Bushing Project to have included in these audits the relevant parameters that accurately and reliably reflect the progress (or not) that the country is making to address bush encroachment and the utilisation of encroacher wood by adding value to it.

The basis of any M&E effort is a properly-defined point-of-departure, a quantitative baseline assessment of the situation at the outset of the period-to-be-assessed. This baseline report has identified that there is little reliable, scientifically-based (i.e. actually measured rather than estimated by experts) and up-to-date information on the density of encroacher bushes in the various agro-ecological zones of Namibia, the bush species composition, the age of the bush stands, the associated rangeland condition, links to financial losses and potential wood yield, etc. These would first have to be quantified by a survey at the country-scale, e.g. by remote sensing at fairly coarse resolution (e.g. 1 pixl = 1 km^2) followed by ground-truthing that calibrates and converts digital codes (mostly from 1-256) into real-life quantitative units (e.g. bush/ha) and identifies those elements that remote sensing cannot identify (e.g. bush species). The remote sensing-part may be technically challenging but is logistically easy as it involves a few experts and lots of computer work. In contrast, the ground-truthing campaign would need a lot of manpower, country-wide travel, time and equipment as well as prior and periodic follow-up training to standardise the field work that brings remotely-sensed information into the realms of farming and land use. The campaign would have to be time-limited to best coincide with the remote images, thus requiring significant effort in terms of man and material. However, the country survey baseline thus established

27: VILJOEN, C., 2013. Capital Holiday on Bush Encroachment Clearing Loans. Occasional report, FNB Agri Division, Windhoek, Namibia.

would be transparent, scientifically credible and accurate enough to inform management for one or two decades, until the environment changes significantly.

Since rapid environmental change in the form of widespread bush thinning is the objective of this De-Bushing Programme, it is envisaged that such ground-truthing campaigns would have to be repeated more frequently than usual. This would enable the surveyors to link their M&E campaigns to other applications that need a finer resolution (e.g. 1 pixl = 250 m^2) to allow for the accurate and rapid assessment of a specific site where a certain intervention is about to be implemented. The site survey would have to be detailed enough to enable project planning and budgeting. Its remote-sensing part could easily be combined with the baseline survey and subsequent M&E surveys, but its ground-truthing part (if needed at all) would have to be the responsibility of the individual project. The various projects would be driven by different stakeholders and this inter-dependency would thus encourage good cooperation and coordination between the De-Bushing Programme, the RCU and the project stakeholders. Combining of forces would yield better results faster than the *ad hoc,* piecemeal approach that has characterised the sector thus far.

If the RCU is the chosen institution for M&E, it would be vital to constitute, fund and equip it adequately to perform this important task. It is also conceivable that a lot of new, good information on bush, its management and utilisation will be generated by a proper M&E process, which could feed into the de-bushing advisory services that are foreseen.

5. Outcome B: Effective de-bushing advisory services

The second major outcome of the De-Bushing Programme is to facilitate a "De-bushing Advisory Service" that acts as a knowledge and resource centre, informing, disseminating, coordinating, networking and linking to encourage the sustainable control of encroacher bush to yield economically feasible, value-added encroacher wood products. To what extent did these functions exist in Namibia in 2014?

Three agricultural extension services are active in Namibia. All offer general production advice on extensive animal production and sustainable rangeland management (including bush control) to farmers (producers) and land users but none offers specialised advisory packages on bush control or encroacher wood utilisation. Advice to industrial users of encroacher wood on value addition is also not part of their service.

5.1 The Directorate of Extension and Engineering Services in the MAWF

Only the Government-funded Extension Service of the MAWF, in the Directorate of Extension and Engineering Services (DEES), operates in the whole country. It is headed by a Director[28] and has an estimated 250 well-structured positions (agricultural extension officers and agricultural extension technicians) to serve Namibia's farming community, completely free of a direct charge (indirect costs arise to taxpayers). Its core function is informing and training farmers and until recently, it divided its resources so that 80% was invested in communal and 20% in commercial areas. It is estimated that Namibia has 350,000-450,000 communal and 3,500-5,000 commercial producers. Theoretically, one DEES extension official serves about 1,600 farmers. The service is decentralised into about 20 extension offices and 10 agricultural and rural development centres country-wide, all of them fully equipped with computers, modern means of communications, four-wheel drive vehicles etc. Extension officials receive farmers and also visit farmers to impart advice and disseminate information in the following ways, many of which would have referred to bush and rangeland issues:

- Farmers' and information days,
- Technical workshops and seminars,
- Radio talks and television programmes,
- Technical newspaper and journal articles,
- Other training and information events.

Theoretically, completed activities have to be recorded but no such register could be found, only planned activities. DEES officials also handle the paper work associated with special Government interventions, e.g. drought assistance, preferential procurement, donor project liaison etc. Nearly each one is provided with a field-worthy four-wheel drive vehicle and can claim subsistence and travel (S&T) allowance when leaving his/her duty station. They report to their local supervisor who reports to a regional Deputy Director who reports to the Director.

The operational wing of DEES is comprised of highly trained and competent technical specialists. For example, in February 2014 there were 121 agricultural extension officers (AEO) and agricultural extension technicians (AET) stationed physically in the northern communal areas. They were structured into 5 Chief AEO, 18 Senior and "plain" AEO, 11 Chief AET, 40 Senior AET and 47 AET; roughly 60% male and 40% female. All these individuals were trained at the tertiary level and although none held a

28 : Ms Sophie Kasheeta, Director of Extension and Engineering Services, MAWF.

doctorate degree, 12 held either a master's or an honours degree, 12 held a bachelor's degree and 97 held an agricultural diploma or certificate. Certainly, DEES can pride itself on its highly trained and competent staff!

What a beautiful set-up and what an asset to the country! Yet, Government's extension service is perceived by farmers and land users to be ineffective and incompetent. The output does not match the infrastructure and staff at all. How is that possible? If it is not a complete misconception, it may be due to the following reasons:

- In the Government service generally and in DEES in particular, there is no expectation of service delivery and there are no consequences to an official if s/he does not do her/his work. Although the disciplinary code of the public service makes it possible to sanction someone who neglects her/his duties, this is hardly ever applied.
- More than 85% of the total DEES budget is associated with personnel expenses and infrastructure maintenance, leaving the operational budget totally inadequate. Each month, extension staff claim to run out of allocations for travel and S&T before the month is over and cease their activities.
- DEES officials do not work on weekends and thus fail to serve the growing segment of part-time, "weekend" farmers in Namibia. These farmers are often amongst the most pro-active and innovative because they are exposed to a larger world than just their own farm and can often afford to subsidise their farming enterprise with off-farm income. They are frequently amongst the most progressive and effective farmers. They should be prime targets of an extension effort.
- DEES officials do not mentor farmers. Often, dissemination of knowledge (training) alone does not have the desired effect and needs to be followed up with a period of mentoring to ensure that practical skills are also acquired.

In addition to these structural problems, it is also apparent that extension officers shy away from animal health matters when these are often the first problems a farmer is faced with. Communal farmers have to be engaged more intensively because many still need to change their attitude towards agricultural production (from subsistence to production/profit oriented) and have to get the basics of farming right (organisation, production, marketing, and infrastructure). The National Agricultural Policy is mute on extension services, although it is doubtful if writing these into law alone will have the desired effect. Furthermore, the Ministry tasked with land reform and the Ministry tasked with agricultural development only started formally cooperating in 2012/13 (signing a memorandum of understanding on cooperation and complementarity of services to farmers), 22 years after the start of the redistributive land reform process.

Theoretically, DEES extension staff inform MAWF's research staff in the Directorate of Research and Training (DART) of farming problems and disseminate research results to the producers. DART's Pasture Science Division, once the biggest research unit, is now manned by only two researchers[29] who are currently not researching bush ecology or control but mapping its distribution. Since the country's leading bush expert, Mr Bessie Bester retired nearly a decade ago, little new information on encroacher bush has become available through DART, although the Polytechnic and a few private researchers are active in this field. Most Namibian researchers on bush encroachment publish in the country's only agricultural journal, "Agricola" and some information is disseminated via the leaflet series "Spotlight on Agriculture". Both are published by the MAWF and have provided valuable, relevant information over the years. Even though most farmers were mailed these publications until recently, few actually read them, preferring to have them interpreted by an extension officer. It is therefore advisable that the De-

29 : Mr Leon Lubbe, referred to earlier under "Extent of bush encroachment" and Mr Jerome Boys.

Bushing Programme support bush research trials which contribute to our understanding of encroacher bush and its effective, sustainable control.

5.2 The Farmers' Support Programme

The GIZ-sponsored "Farmers" Support Programme" (FSP)[30] is mainly a training and mentoring organisation focussed on "affirmative action loan scheme" farmers in commercial areas and "small-scale commercial farmers" in communal areas. It has about 25 technical positions (i.e. trainers, mentors and extension specialists) at an approximate rate of 1 official: 300 clients. This free service originated with the GIZ but its institutional home, the Agricultural Bank of Namibia (AgriBank) contributes 50% of its annual budget. Since AgriBank is a state-owned enterprise, these funds eventually derive from the Namibian taxpayer. The FSP has a lean organisational structure and most of its technical experts ("mentors") work for FSP only 5 days a month. Most mentors are former or active farmers themselves, working according to the motto of "farmer helping farmer".

In 2008, the FSP under the "Joint Presidency Committee" of the two largest farmers' unions, NAU and NNFU, published eight ring-bound guides and manuals (also available electronically) on the following topics:

- Rangeland Management (chapter 7 is titled "Regenerating degraded rangelands" and includes a section on bush encroachment and methods to treat it),
- Large Stock Management,
- Small Stock Management,
- Crop Production,
- Animal Health,
- Mechanics,
- Labour, and
- Farming Finances.

These proved very popular and the first print run of 3,000 copies were distributed within months, free-of-charge. A second print run of 3,000 has also since been exhausted.

5.3 The Meat Board Mentorship Scheme

The third Namibian extension service is strongly linked to the country's meat industry with a focus on beef cattle production. The Meat Board of Namibia's (MBN) communal mentorship scheme[31] arose from the Livestock Producers' Organisation, is operated by the MBN and is funded by a levy collected by MeatCo on every animal slaughtered at its commercial abattoirs as well as donor-funded. Its 2013/14 budget amounted to N$4.5 million of which 80% was available for operations. It targets MeatCo clients with specialist training and mentoring services and links clients to various MeatCo and MBN schemes, e.g. the Ekwatho Scheme (which has its own Ekwatho mentors). This scheme promotes beef production to better utilise the slaughtering capacity of MeatCo's two export abattoirs (at Windhoek and Okahandja). It facilitates "emerging" producers to access loans (from private banks and AgriBank) to buy additional cattle and guarantees a slaughter price. At slaughter, all financial transactions are reconciled and hence, a farmer is able to stock up which otherwise s/he may not have been able to afford.

30 : Headed by Ms Elaine Smith.
31 : Headed by Mr Gizaw Negussie.

In the meat production process, farmers are intensively mentored by less than 25 part-time, technical specialists (February 2014) at a ratio of 1 mentor: 72 clients. The 14 mentors serving the northern communal areas work 4-5 days/month and have served 899 mentees over the last three years. Most mentors are active or former farmers and are well trained: one has a PhD, two hold bachelor degrees and 11 hold agricultural diplomas or certificates. The MBN mentorship scheme has regional steering committees that liaise and coordinate with other stakeholders, especially DEES. Despite this very intensive consultation and competent, directed staff, efficiency of service delivery is, by own admission, still only 60%. Yet, mentors can achieve more than conventional extension officials because they engage farmers more intensively, over a longer time period and over weekends.

5.4 Decision support

In the absence of an effective extension service, who advises farmers in matters of bush control and associated rangeland rehabilitation? A lot of experts offer individualised advice, but there are only two functional and one in-the-works expert decision support systems (DSS) operational in Namibia.

An online DSS derived from research and indigenous expert knowledge was developed for the management of arid rangelands in (central) Namibia by rangeland and IT experts of the Polytechnic of Namibia under the leadership of Dr. Dave Joubert[32]. This DSS is functional and has been field-tested although it is currently offline due to computer software problems. It incorporates bush encroachment into its "problem tree" of leading questions that leads users step-wise to the eventual recommendation.

A similar DSS, EcoRestore[33], was developed by Prof. Klaus Kellner and Ms. Anita Barac of the North-West University in Potchefstroom, South Africa, in 2003 for southern African savannas generally. It is based on two separate data bases called GrassExpert which focusses on technologies to reclaim degraded rangelands and BushExpert which focusses on control of bush encroachment and alien invasives. This system is fully operational.

A third open source expert system is in the process of being developed in the USA, but with field testing and applications in Namibia as during the monitoring and evaluation of MCA-N CBRLM. Dr. Jeff Herrick and others are building a global, cloud-computing-based Land-Potential Knowledge System (LandPKS)[34] to match land use with land potential that can be called from a mobile phone and considers climate and crop aspects in addition to rangeland management.

An important back-up system to these DSS is Prof. Nico Smit's BECVol 3 computer programme[35] which allows estimation of browse yield and wood yield per hectare based on 8 tree measurements taken in a representative transect. This method has the potential to predict the wood yield of a site accurately and reliably, thus greatly facilitating efforts to utilise its wood industrially. The De-Bushing Programme might evaluate and test the usefulness of existing quantitative wood yield methods under local conditions.

32 : JOUBERT, D.F., I. ZIMMERMANN, J. FENDLER, H. WINSCHIERS-THEOPHILUS, F.P. GRAZ, G.N. SMIT & M.T. HOFFMAN, 2014. The development of an expert system for arid rangeland management in central Namibia with emphasis on bush thickening. *Afr. J. Range & Forage Sci.* 31(2): 161-172.

33 : BARAC, A.S., 2003. EcoRestore: A Decision Support System for the Restoration of Degraded Rangelands in Southern Africa. M.Sc. thesis (Botany), North-West University, Potchefstroom, South Africa.

34 : HERRICK, J.E., *et al*., 2013. The global Land-Potential Knowledge System (LandPKS): Supporting evidence-based, site-specific land use and management through cloud computing, mobile applications and crowdsourcing. *J. Soil & Water Cons.* 68(1): 5A-12A.

35 : SMIT, G.N., 2014. BECVol 3: An expansion of the aboveground biomass quantification model for trees and shrubs to include the wood component. *Afr. J. Range & Forage Sci.* 31(2): 179-186.

Although very sound and applicable, anecdotal indications are that farmers do not use these DSS on a large scale. Apparently, they like a DSS to be interpreted to them by an expert. This implies that the various DSS have more value when used as technical back-stopping to advisory services than for farmers directly.

5.5 Some recommendations on advisory services

Should the De-Bushing Programme create yet another training/mentoring service to compete with these three entities? Or should it not duplicate these services and rather boost and expand existing services in a number of ways? It is recommended that the De-Bushing Programme should not add another actor to this already crowded field but rather support existing initiatives and services:

- Direct contributions to existing budgets and services, e.g. supply budgetary assistance to increase the number of farm visits by boosting travel and S&T budgets. In this manner, the operational efficiency of existing services is improved.
- Develop further technical and production literature that can be used for training of producers and of trainers (e.g. extension officers). In this manner, the technical competence of existing personnel is updated and increased, particularly in the fields of sustainable rangeland management, bush control and encroacher wood use. Training material can be branded to acknowledge its source.
- Digitise some of the training and information material and place it on a website with links to the DSS discussed earlier. Farmers are increasingly relying on the internet for technical information and this seems an ideal way to increase the audience for a specific message. The website can be branded and could sustain itself if advertising revenue (e.g. from relevant agricultural input suppliers) is generated. Cooperation with the to-be-formed RCU is highly recommended as the RCU will have a similar need to get relevant information out to producers speedily.
- Design and implement a “continuous professional development” programme for technical staff that increases their technical knowledge and boosts their practical skills (applied knowledge). If CPD events can be certified by a competent national regulatory body (e.g. NTA, NQA), certification of participants can become a prerequisite for career advancement. In this manner, technological progress is incorporated into existing services on a continuous basis.
- Assist existing services by the creation of specialised groups of employees and non-GRN experts tasked with addressing a specific issue or solving a specific problem (a “task force”). Task forces operate on a project basis in that they are task- and term-limited and get disbanded once their job is done (project management). They get funded by donors or, sustainably in the long term, by levies on products (e.g. on meat, skins or milk if the task is food production-related or on wood and wood products if the task is related to adding value to encroacher wood). In this manner, budgetary efficiency is enhanced because staffs are not employed for life, but only for the duration of a project. Under-achievers can be dropped without legal complications while high achievers get included in the next task. Task forces can also be branded to acknowledge their source.
- Assist existing advisory services to add an industrial dimension on the use and value-addition of encroacher wood, or create such service anew since it does not already exist.
- Engage Government to improve service delivery generally and in its MAWF specifically.
- Most commercial farmers expect general production information to be availed for free. It is freely available on the internet and was also offered free-of-charge by state-owned extension services before and after independence. However, it appears that too much of the budget allocated to state-owned research and advisory organs is used to maintain the existing machinery (salaries, infrastructure) rather than to deliver services (operations), thus service delivery has decreased since independence. Generating information costs money (from research to publicising) and the De-

Bushing Programme might investigate ways in which these funds can be collected to contribute to a sustainable advisory service. In the past, some specialised services were funded by levies on the relevant products, for example.

The specific training needs identified so far during the baseline assessment include the following:

- Charcoal-making for charcoal-makers: NQA level 2
- Charcoal-making for land owners: NQA level 4 or 5
- Bush control for farm workers and arboricide applicators: NQA level 2
- Bush control for land owners: NQA level 4 or 5

Of equal importance for the De-Bushing Programme is that the envisioned "De-Bushing Advisory Service" links training and capacity building to market opportunities for encroacher wood, including training in the conversion of encroacher wood to useful products and links this to the SME sector (possibly with the assistance of Namibia's Business Innovation Centre, SME Bank, etc.). For example, the manufacture of simple gardening equipment such as bedding edging can be taught, but manufacturers could also be linked to retail outlets selling these products and to the NSI to produce wood products of standard and verifiable quality. In other words, the advisory service is much more than a training organisation. It should also be at the centre of a network of contacts linking and enhancing supply and demand of encroacher wood and similar products.

6. Outcome C: Growing the value chains of encroacher wood

The third major outcome of the De-Bushing Programme is to grow the various value chains that use wood from encroacher bush. Five major value chains of encroacher wood are fully operational or have great potential in Namibia:

- Industrial combustion value chain: wood or wood products such as charcoal used for heating and direct-firing of industrial combustion chambers such as furnaces and boilers,
- Industrial energy value chain: wood or wood products used to generate electricity at an industrial scale,
- Domestic energy value chain: wood or wood products used for domestically for energy,
- Building materials value chain and
- Animal feedstuffs value chain.

All these chains but the industrial-scale energy chain was fully operational in Namibia in 2014.

The industrial combustion value chain is particularly well established and consumes about 330,000 tons of wood per year. The use of wood for domestic energy is well-known but difficult to quantify. Informal firewood consumption has been estimated to consume 440,000 tons of wood and formal firewood consumption 45,000 tons per year. The building materials and animal feedstuffs value chains were small and poorly developed in 2014. In terms of value, most wood is used for domestic purposes (cooking, heating, recreation, structural), followed by charcoal-making, then direct-firing of industrial furnaces and then, for power generation[36]. If unquantifiable amounts of wood use are included (e.g. large quantities of firewood cross our country's borders outside of any regulatory channel), total wood use in Namibia may approach 1,000,000 tons per year, considerably more than the 601,000 tons/year estimated recently[37]. This is still only 3% of the possible annual use potential of Namibian biomass of 23.4 million tons per year[38].

6.1 Industrial combustion value chains: Charcoal

Making charcoal from wood harvested on Namibia's rangelands has been practised in Namibia for 60+ years but has only really taken off at an industrial scale over the last three decades. The industry has now matured to a point where it is ready to be transformed, renewed and invigorated. The discussion below focusses on industrial-scale charcoal production as charcoal made for domestic purposes is not quantifiable and probably insignificantly small compared to industrial charcoal, even though its domestic use goes back a very long time.

Charcoal is made by heating wood (or other organic substances) in the absence of oxygen. Thin wood results in small, low-grade charcoal while thick pieces of wood burn into large, high-grade charcoal. Oxygen is infused only at the start of the process during the combustion stage (dehydration phase) and a thick, moist, white smoke is emitted. Once the fire is established, oxygen supply is reduced and the wood carbonises into charcoal in an exothermic reaction. The smoke now changes to hot, yellow and oily and is very polluting and noxious. When carbonisation is complete, the kiln is cooled off and the charcoal removed for further cooling. It is then pre-screened and packed (commonly into 50 kg bags) for transport to factories. Conversion efficiency of wood to charcoal in Namibia's commonly used mobile

36 : Dr. Detlof von Oertzen, pers. comm., 2014.
37 : STEAG ENERGY SERVICES, 2013. *Study on Namibian Biomass Processing for Energy Production.* Occasional report of STEAG Energy Services GmbH/Transworld Cargo (Pty) Ltd, Essen, Germany.
38 : STEAG ENERGY SERVICES, 2013. *Ibid.*

drum kilns is only 10-25% and depends on the type of wood and skill of the operator. Namibian kilns commonly need 4-6 tons of (wet) wood to produce 1 ton of charcoal, have a content of about 1.5 m^3, can produce 20-50 tons of charcoal a year and give off a lot of smoke and noxious gasses. Internationally, these types of kilns are mainly used where the wood source is dispersed and not dense. We use them because they are easily transportable and manageable by a single operator. Larger and newer types of kilns that carbonise wood more efficiently (up to 50% conversion efficiency) and give off fewer noxious gasses are however, available.

Picture 6: Charcoal from partially burning wood in kilns

Picture 7: Kiln activity in the Ugab valley

Charcoal can be processed further into different shapes (e.g. briquettes, pellets) and formats (e.g. activated charcoal or biochar). Smaller charcoal fragments are compressed into briquettes and pellets, using various additives to improve adhesiveness. Biochar is made by heating charcoal in the presence of gas to increase the pore size. This enables biochar to adsorb ("trap", filter) chemicals ("activated charcoal" for medical uses) or water (as a soil ameliorant), making it suitable for a wide range of uses in Namibia[39], even earning carbon credits under the Kyoto protocol[40] (which has since expired and was not replaced by a similar agreement, provisionally spelling the end of the carbon market). Sometimes, barbeque charcoal is dipped in wax to alight easier (easy-light charcoal). Charcoal gives off more carbon monoxide than wood and should not be burned in an unventilated environment. Since charcoal burns at an intense heat that is double the temperature at which steel melts, it has many industrial applications where intense heating is required. It also serves as chemical feedstock for synthetic fuel.

6.1.1 The Namibian charcoal industry[41]

In Namibia, most charcoal is made by sub-contractors who are not employed by the land owner on whose property the charcoal is made. More than 5,000 small-scale charcoal makers comprise the basis of the industry, working mainly on farms in central and northern Namibia (although most recently charcoal is also being made from invasive *Prosopis* trees in south-eastern Namibia). Most charcoal makers are not organised into a representative industry body, are not trained, mechanised or professional. This imposes serious limits on increasing charcoal production.

In contrast, the next level of the industry is well structured. Many land owners on whose property charcoal is made and nearly all of the largest charcoal processing factories are members of the Namibian Charcoal Producers' Association (NCPA), with about 500 registered members (App. V). The association is registered with the Namibian Agricultural Union (NAU) as a producers' organisation. There are many hundreds more charcoal producers, mainly smaller producers, who are not registered with the NCPA, especially amongst communal farmers. The non-members also deliver charcoal to the big factories and are thus part of the statistics mentioned below. Most of the charcoal produced is delivered to nine big processing factories (App. V) that are responsible for distribution and export of the final product.

Namibia produces between 60,000 and 158,000 tons of charcoal annually (using 240,000-600,000 tons of wood/year), depending on the ability of producers to burn wood (less wood is burned in very wet years, or when labour is scarce) and the demand of the export market. Nearly all charcoal is exported: about 60% to South Africa (the majority used for industrial purposes, e.g. in silicon smelters) and 40% to Europe (mainly Great Britain and Germany and mainly for recreational purposes, e.g. to fire barbeques). Smaller charcoal of lower quality and price is used in industrial processes while recreational charcoal has to be bigger and of higher quality. Lately, demand has increased dramatically and Namibia is not able to meet all requests for charcoal. The main reason is a radically larger demand in South Africa because their wood is becoming scarce, amongst others because the "Working for Water" campaign successfully eradicated alien invasive bush species in South Africa that used to supply firewood and an increasing demand for barbeque fuel by an increasingly affluent population.

39 : ZIMMERMANN, I. & H. AMUPOLO, 2013. Conversion of encroached bush to biochar for improved soil and livestock. *Agricola* 23: 14-19.
40 : VON OERTZEN, D., 2009. Biochar in Namibia. Opportunities to convert bush encroachment into carbon offsets. Occasional report, VO Consulting, Swakopmund, Namibia.
41 : For an exhaustive discussion of the charcoal industry in Namibia, its historical development and regulatory framework, labour relations including linkages to gender and HIV/Aids, problematic issues and recommendations, see DIEKMANN, U. & T. MUDUVA, 2010. *Namibia's Black Gold? Charcoal Production, Practices and Implications.* Legal Assistance Centre, Windhoek, Namibia.

According to some stakeholders interviewed, Namibia could export 3-5 times more charcoal than it is currently producing, but Namibia cannot currently produce this much charcoal – and it is not for lack of wood.

Currently (2014), the standard price of charcoal for the land owner is N$1,400/ton while the sub-contracted charcoal burner receives N$600-700/ton. The average worker can produce 1 ton of charcoal per week.

6.1.2 Regulation of the industry

The charcoal industry is regulated mainly by two Acts, the Forest Act of 2001 and the Environmental Management Act of 2007. The Forest Act does not apply well to the charcoal industry. Charcoal-making is based on the utilisation of encroacher bush and not forest tree species. In practice, the most chaffing regulations pertain to protected tree species, many of which (e.g. camelthorn, mopani) do become encroaching in certain parts of the country, where they may be released from protection. Secondly, many encroaching species grow in tree- and in bush-form. Tree forms should be protected irrespective of species as they are benign, even beneficial to rangelands, while bush forms should be released from protection. Thirdly, the charcoal industry complains about being singled out for discriminatory persecution for harvesting large specimen of protected species. What about the unselective application of arboricides, which are completely unregulated and kill woody plants off indiscriminately? The question also arises whether the Directorate of Forestry (DoF) is the appropriate Government institution to house bush management regulations, since bush control is a rangeland issue and only an exceedingly small fraction of Namibia's rangelands can be considered to be forested. Once amended (Forest Act) or regulated separately (e.g. by revived Bush Encroachment Management Regulations), the appropriate regulations need to be implemented effectively and the industry controlled properly to ensure sensible and sustainable resource utilisation.

The DoF regulates by issuing harvesting permits to charcoal makers, which have to be renewed upon site inspection every 6 months. However, DoF does not have posts for "inspectors" *per se.* Instead, inspection is done by Forest Guards, Rangers, Technicians and Foresters as part of their normal working routines. It appears obvious that this is not possible and in practice, very few inspections are carried out. Other permits issued by DoF to regulate the industry are the marketing permit, the commercial transport permit, the commercial export permit and the "own-use" permit. Lack of implementation capacity results in large-scale abuse of the natural resource. It is alleged that protected species of trees and thick-stemmed individuals are cut for high-grade charcoal production, when it is thin-stemmed individuals of unprotected woody species that are at the core of bush encroachment, but they are avoided because they yield low-grade charcoal. If an individual farmer wants to enforce the appropriate regulations, his sub-contracted charcoal makers "abscond" to a neighbour who is not as strict and allows them to continue their indiscriminate harvesting.

The Environmental Management Act is not aimed specifically at the charcoal industry but generally at the sustainable management and utilisation of natural resources. It is not quite clear when it applies to individual charcoal makers and is also not yet implemented in full in practice. The problematic issues associated with these two Acts and their implementation capacity (or lack thereof) was already a problem when Diekmann & Muduva compiled their reference work in 2010. Alas, it appears that little has changed since then. Their environmental recommendations and recommendations to all stakeholders, also to be discussed later, are especially relevant to the De-Bushing Programme.

The Forest Stewardship Council (FSC) is a voluntary, independent, non-governmental and not-for-profit international organisation that promotes sustainable wood use by an environmental certification process that includes international audits on-farm, setting of strict product standards and trademark assurance. It is applied since 1997 especially to charcoal exported to high-end markets (Great Britain, Germany and other European countries) but is not required in South Africa, Namibia's major charcoal market. Even though FSC certification is not compulsory, it conveys a distinct marketing and price advantage and should be wider applied. Its requirements are stricter than that of the DoF permit regulatory system.

The National Rangeland Management Policy and Strategy of 2012 encourages charcoal production as a means to utilise encroacher bush and rehabilitate degraded rangelands. It also advocates for a revival of the dormant Bush Encroachment Management Policy.

In all these Acts and Policies, the role of fire is one-dimensional, that of destroyer-in-chief. It is often mentioned that "3-7 million hectares of land are *destroyed* annually by fires in Namibia". Certainly, fires destroy man-made infrastructure and forests, but their effect on rangeland, especially bush-encroached rangeland, can be *regenerative* if applied correctly. New cognisance needs to be taken of the proper use of fire in rangeland rehabilitation and sustainable utilisation rather than indiscriminately discarding the good with the bad.

6.1.3 Some challenges to the industry

The charcoal industry through its mouthpiece, the NCPA, identified the following major problems that the GIZ De-Bushing Programme could possibly address:

- Inability of charcoal supply to meet demand, caused mainly by the use of inefficient, small kilns, an untrained workforce that relies on archaic manual harvesting methods, overly-rigid and protective labour laws that discourage employment and inadequate incentive policies. Just converting charcoal makers from manual to semi-mechanised producers equipped with chain saws and mechanical brush cutters has been estimated to triple the annual production of charcoal[42].
- The production of environmental pollutants (e.g. smoke) and hazards (e.g. ignition of involuntary veld fires) during harvesting and field processing.
- The preference of charcoal makers to harvest thicker stems rather than thinner stems due to existing price incentives and lack of further (down-line) charcoal processing, which explains why charcoal-making currently does not contribute significantly to bush control and rangeland rehabilitation.
- Labour issues: these are detailed by Diekmann & Muduva (2010) and have not changed significantly since then. Therefore, their recommendations are also still valid. The only perceptible change is that more and more women are becoming involved in the on-farm sorting and packaging of charcoal, whereas the actual harvesting and controlled burning of wood is still predominantly a male preserve. One would think that such changes in the on-farm gender balance have implications for HIV/Aids management. A stronger, more representative industry association (like the NCPA) would go a long way towards addressing these problems effectively.

42 : VON OERTZEN (2012) calculated that it would take 42 "manual" charcoal makers (the current situation) or 13 semi-mechanised bush cutters to produce the same amount of charcoal that one completely mechanized operator of a skid steer harvester could produce in a year. Since the idea is not to save jobs but to expand production, the same number of charcoal makers could produce three times the amount of charcoal if semi-mechanised compared to manual production.

6.1.4 Some recommendations for the charcoal industry

- The charcoal industry has matured: it has a large production base, established markets and experienced operators. It needs to improve its regulatory, administrative and financial responsibilities to come in line with its level of maturity as an industry.
- The Programme should promote the streamlining of the Forestry Act to address grey areas (e.g. should mopani be a protected or a problem species under the Act?) and make it better applicable to the charcoal industry; alternatively develop a new set of regulations specifically for the charcoal industry (or revive the dormant Bush Encroachment Management Regulations).
- The Programme should address the issue of insufficient inspection of DoF permit holders and untrained operators: There are more than 5,000 individual charcoal makers, each with multiple kilns, distributed over millions of hectares. Many kilns are located in rough terrain in remote areas not easily accessible by vehicle. With such conditions, it is not easy to perform regular, semi-annual inspections of harvest sites and harvesters, especially without dedicated DoF "inspectors". A possible alternative is to change to a certification system in which every charcoal maker has to attend an accredited (FSC? NQA?), practical training course about how to make charcoal sustainably before a harvesting permit is issued. Harvesting permits have to be renewed regularly (bi-annually?) after attending a refresher course. The training courses for charcoal makers should be very practical and include "learning by doing"; pitched at about NQA level 2.
- A different FSC-certified training course should be offered to land-owners before they obtain a transport and marketing permit. This course is more theoretical to explain the dos and don'ts of charcoal making and bush harvesting but includes practical aspects. It should be pitched at an NQA level of 4-5. Without attending such a course, no land owner should receive a permit to transport and market charcoal.
- Normally, people who get trained and assisted are more likely to stick to regulations than those that are merely policed. However, spot inspections should still be carried out to check up on trained land owners and charcoal makers. If a charcoal maker is found to transgress regulations, his harvesting permit is withdrawn for 6 months and can only be re-issued upon attending another training course. The offending land owner who sub-contracted this charcoal maker is fined (progressively). DoF will have to create special "inspector" positions to administer this system of regulation by certification and permits, as it cannot be expected of Foresters, Forest Technicians and Rangers to perform inspections as part of their routine work. Alternatively, the charcoal industry has to develop and fund an effective training, regulating and inspection system itself.
- The Programme should investigate if professionalization of charcoal making is an option; analogue to what happened in the game animal industry where professional hunting teams have taken over large-scale culling operations that over-burden game ranchers and fall outside the realm of "hunting". Specialised, mobile professional charcoal making operations would significantly increase production without necessarily reducing employment opportunities and would be easier to control and regulate.
- The Programme should facilitate the transformation of the charcoal industry from manual to mechanised or semi-mechanised, by furthering the introduction of appropriate new charcoal-making technology to Namibia and supporting the demonstration and/or pilot-testing of new equipment/processes. In order to protect existing jobs, the mechanisation recommended is not to switch over to large harvesting machines, but rather to mechanise the individual charcoal makers (e.g. by substituting an axe with a chain saw or mechanical bush cutter) and to introduce more effective, less polluting kilns. One such opportunity will arise at the Charcoal Information Day with Annual General Meeting of the NCPA in Otjiwarongo on 15 October 2014, at which some South African and overseas investors and innovators will demonstrate some of their technology.

Some equipment and/or processes may have to be piloted on a limited, experimental scale before being released for general commercial use. Semi-mechanised harvesting would increase the rate of wood extraction, speed up processing before burning and attract more workers to an industry that is struggling to recruit workers due to its "unhealthy, dirty and exploitative" image. Larger, more efficient kilns go hand-in-hand with up-scaled bush extraction methods.

- The Programme should facilitate briquette-making technology and the adaptation of charcoal factories to process small charcoal and char dust into pellets (small, for distribution to humanitarian organisations to supply a daily ration for cooking to refugees) and briquettes (for the recreational barbeque market and indoor heating). This would encourage charcoal makers to utilise the small and thin-stemmed bushes that are at the core of the bush encroachment problem and turn dust, sweepings and fragments from waste into valuable by-products.

6.2 Industrial combustion value chains: Direct-firing

This is the second of two operational, industrial-level combustion value chains. The use of encroacher wood to direct-fire industrial combustion chambers (e.g. kilns and furnaces) is only about a decade old, thus still in its infancy and only now starting to diversify.

6.2.1 Ohorongo Cement

Currently, there is only one major institution that uses wood from encroacher bush to fire their industrial combustion chambers: Ohorongo Cement uses air-dried wood chips to replace anthracite in their cement kilns. The cement factory belongs to Schwenk Zement KG, was commissioned in Namibia in 2010 and will be able to produce 700,000 tons of cement annually when at full production. Its kilns were designed to accept anthracite as well as any type of organic matter as fuel. The strategy was, from the start, to tap the enormous amount of energy locked up in encroacher bush by using its wood to direct-fire the kilns.

Picture 8: Wood chips produced by chipping live bush

In 2014, the total demand of Ohorongo for wood was 85,000 t/year. At full capacity, 75% of Ohorongo's energy needs could be met by wood biomass and 25% by fossil coal (anthracite). A sister company,

Energy For Future (EFF) is tasked with harvesting encroacher bush in a 100 km radius around the cement plant, chip and dry it and deliver it to the cement kilns. This is achieved by huge, mobile, extremely expensive bush chippers that harvest and chip bush in the same operation. Farmers avail their farm for bush harvesting and after an inspection for suitability, a contract is signed. On every farm, an area not larger than 200 ha (in the meantime increased to 500 ha) on relatively flat terrain is clear-cut, leaving isolated strips or clumps of dense bush for a quite unnatural appearance of "selective harvesting". A total of 4,000 hectares is harvested per year. At roughly 10 tons of wood per hectare, initial wood harvest came to 40,000 tons/year, roughly half the maximum demand. Farmers are queuing up for this service because their desperation to thin encroacher bush is huge, enabling EFF not to have to pay for harvesting a natural resource (encroacher bush) that displaces an expensive, imported commodity (anthracite) in the cement production process.

Whether or not the removal of encroacher wood by EFF contributes to sustainable rangeland improvement for livestock ranching appears not to have been a major consideration, although considerable effort was invested in sustainable harvesting operations that adhered to best practices identified in an environmental management plan[43] (e.g. a degree of selectivity in harvesting, limiting individual harvesting areas to 200-500 ha, etc.). Unpublished studies have shown that 63% of cut stems on clear-cut areas survive, coppice and will eventually re-create a dense bush thicket. Farmers are not advised or assisted to treat this re-growth if they want to retain an open field. From a ranching perspective, this is clearly an undesirable outcome.

In order to attract more wood and save on harvesting expenses, EFF is now also buying wood directly from others (so-called "third parties"). Their huge and expensive bush chippers are taking tremendous strain. They break down frequently due to the hardness of indigenous wood and its high sand content that grinds down the hardest steels within a couple of years. The roughness and dustiness of the terrain impacts the mechanical integrity of the large, heavy machines, which run up huge repair bills. They are probably not the right machines for the local conditions. Thus, farmers are now paid to deliver wood to the factory gate: N$300/ton of raw wood and N$700/ton of 10% air-dried chips (subject to quality norms and controls)[44]. Obviously, EFF based these prices on their own harvesting expenses and they are highly competitive with the farmer's break-even price of N$124/ton of raw wood that includes transport of 10 tons for 45-58 km as calculated by Honsbein *et al.* in 2009, even allowing for inflation of 6% p.a., which elevates the break-even price of raw wood to N$166/t in 2014.

Recent industry speculation has it that EFF was not profitable and is being wound down because third parties may be able to deliver wood cheaper and more effectively to the parent company than its sister company. Thus, Ohorongo's commitment to utilise encroacher wood in its cement production process remains unaffected by the change in supplier.

43 : CHRISTIAN, C., 2010. *Environmental Impact Assessment Report, Energy for Future: Bush-to-Fuel Project.* Environmental impact assessment report, Colin Christian & Associates, Windhoek, Namibia.
44 : ENERGY FOR FUTURE, 2014. *3rd Part Wood: Update 19 June 2014.* Power Point presentation obtained from Tobias Konzmann, Energy For Future, Windhoek, Namibia.

6.2.2 Emerging operators

Some operators have already reacted to this "pull" factor by signing contracts to deliver wood to EFF/Ohorongo Cement. This initiative deserves to be supported by the Programme because it will probably help establish a "wood market" in Namibia from which other value chains may also benefit in future. In anticipation of such developments, some private companies (Olthaver & List Energy, Transworld Cargo, Ohorongo Cement – provisionally dormant and most recently Omariru Biomass Investments) have formed "Woodco (Pty) Ltd" to be ready to harvest encroacher wood and use it for various purposes but primarily for energy generation. WoodCo aims to offer a complete package to whoever needs encroacher wood on a grand scale, including harvesting operations, aftercare of the harvested land, pre-processing on-farm, transport logistics, fine-processing before use, optimising wood-firing technology, marketing and compliance with legal requirements and voluntary standards.

The potential users of huge quantities of encroacher wood could be, amongst others:

- If NamPower's plans to erect a 20 MW biomass plant at Ohorongo to make use of their wood harvesting mechanisms materialises, such a plant needs 450 t/day of processed wood biomass such as torrefied biomass or "green coal". This is just one of several potential biomass or co-firing plants.
- Olthaver & List subsidiary Namibia Breweries have calculated that they need 3,000-3,500 tons of wood biomass per year to co-fire their industrial beer-brewing boilers. Apparently, at the time of writing, O&L had ordered a wood-fired boiler to use during the beer brewing process and test and evaluate the use of encroacher wood for this purpose, but the boiler had not yet been commissioned. In case trials show that this method is feasible, another subsidiary, O&L Energy is geared towards supplying wood to the breweries on a large scale.
- MeatCo is interested in the possibility of co-firing their industrial combustion chambers at their two export abattoirs but has not yet estimated the quantity of wood needed.
- Another MeatCo plan is to build massive beef cattle feedlots at Gobabis and Otjiwarongo to grow out the weaner calves that may no longer be exportable to South Africa (where they would have been grown out in feedlots, too) due to new, stringent animal health regulations. This development may provide an opportunity to grow the animal feedstuff value chain (discussed later) and accommodate industrial by-products of the beer brewing industry (brewer's yeast, included in O&L Energy's plans).

Such an extraction-and-utilisation industry would benefit from good organisation and structuring from the outset to avoid the dilemma of the charcoal industry, where different harvesters under-cut each other to the detriment of the whole industry and the environment.

6.3 Energy value chains: Industrial scale

The energy content of encroacher bush in Namibia is about 5 kWh/kg. It is thus a valuable indigenous energy source that could be used to generate electricity. It has been calculated[45] that biomass, of which encroacher bush constitutes the major component, contributed about 16% of Namibia's total energy needs of about 20 TWh in 2011:

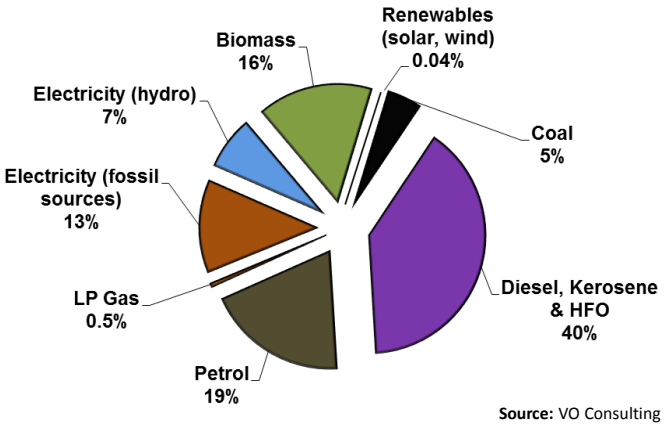

Figure 2: Namibia's energy needs in 2011

Most often, bush biomass is processed only into chips before being used in electricity generation, as further processing (e.g. compressing, heating, extrusion, etc.) would add significantly to the price of the biomass product. Chipping reduces the bulk volume of raw wood, reduces its transport costs and aids rapid drying of the wood product (further reducing bulk).

6.3.1 Electricity from bush biomass

Currently, there are no industrial-scale electricity generation activities based on bush biomass operational in Namibia. The reason, as industry insiders assert, lies primarily with the institutional impediments of Namibia's energy policy which virtually denies the pivotal role that could be played by renewable energy in addressing the country's looming electricity shortage. It starts with as basic a document as Vision 2030, which spells out the path to Namibia's industrial development. This visionary document is mute on where the electricity for Namibia's industrial development should come from. The White Paper on Energy Policy of 1998, while emphasising the importance of independent power producers (IPP) does not address NamPower's monopolistic position in Namibia's energy generation and transmission sector. This is not conducive to expand traditional electricity generation to include Namibia's ample resources of renewable energy, of which wood biomass is one of the lesser ones compared to solar and wind energy. As long as unfavourable price structures and grid connectivity discourage the integration of renewable energy sources into the national electricity system, there is little reason to believe that energy generated from bush biomass will become a growth industry that can

45 : VO Consulting, 2014.

exist on its own economic merits, without considerable subsidies. Suggestions on updating and modernising the regulatory framework of Namibia's energy sector were made some years ago[46] and await further action, with which the De-Bushing Programme might assist.

A prime example of the stifling effect on the energy sector of a single buyer, generator and transmitter of electricity is the country's only pilot independent power producer (IPP), of the Combating Bush Encroachment for Namibia's Development (CBEND) project implemented by the Desert Research Foundation of Namibia (DRFN) with EU funding[47]. This wood-fired, 0.25 MW gasifier plant is in the Outjo district and needs nearly 8 tons of dry wood per day (± 3,000 t/yr). It takes 5 workers and 1 tractor driver (working in shifts) to clear 1 hectare of veld daily to obtain this yield; less hectares if bush is thinned selectively. It also requires 16 m^3 of water for evaporative cooling per day, which is a big disadvantage for an arid country because it forces a choice between electricity and fresh water. It is estimated that as much heat is generated during gasification as electric power and if all this heat is lost, it reduces plant efficiency considerably. Unfortunately, the plant is running at less than 60% capacity. For every 1 kWh of electricity the plant could generate, only 0.7 kWh arrives in the distribution system. This power factor could readily be corrected, but does not get solved due to the problems of selling bio-energy into the national electricity grid, despite the IPP having negotiated a power purchase agreement with NamPower and obtained an electricity generating license from the Electricity Control Board. This IPP is just one of many potential projects that aim to generate electricity profitably from bush biomass (e.g. the VTT study, Leinonen, 2007).

If the regulatory landscape were to change and facilitate the generation of energy from renewable sources, energy from bush would be an economically attractive option indeed. Its levelised cost of energy (LCOE) ranges from N$2.55/kWh if generated mostly by small, decentralised 0.1 MW plants to N$1.43/kWh if generated by a few, centralised 10 MW plants. In the latter case, transport of wood from harvest to generation site could easily become prohibitive. However, the LCOE of bush biomass compares favourably to that of coal-fired plants, which range from N$1.39/kWh for smaller 50 MW plants to N$1.17/kWh for larger 200 MW plants if no carbon tax is included. The same LCOE for coal-fired plants increase by 16% if a carbon tax of N$200/ton of carbon is included in the cost of coal-fired plants[48].

Comparing different energy sources on the basis of price alone is very one-dimensional and does not consider the quite considerable (dis-)advantages associated with a specific energy source. While cost savings per kWh generated by bush biomass may be fairly low, it is a local resource that does not need to be imported so its foreign exchange savings is high compared to energy from coal. Further, the local job creation potential of bush energy is very high compared to that of coal energy in a Namibia without a significant fossil fuel extraction industry (in other words, this comparison may change if commercially-exploitable coal, oil or gas deposits are developed). Similarly, the local capacity development potential of bush energy is very high compared to coal energy. Finally, the total environmental footprint (that includes emissions of particulate matter, various gasses such as CO_2, SO_2 and NO_2 and water use during harvesting, transport and generation) of bush energy is much lower than that of coal energy[49].

46 : VON OERTZEN, D., 2010. Namibian National Issues Report on the Key Sector of Energy with Focus on Mitigation. Consultant's report for UNDP, Windhoek, Namibia.
47 : For more information on environmental and bush fuel aspects, see CHRISTIAN, C., 2009. *Strategic Environmental Assessment for Combating Bush Encroachment for Namibia's Development.* Consultant's report, National Planning Commission, Windhoek, Namibia.
48 : VON OERTZEN, D., 2012. *Namibia's Energy Future: A Case for Renewables.* Occasional report, Konrad-Adenauer-Stiftung, Namibia-Angola Country Office, Windhoek, Namibia.
49 : VON OERTZEN, 2012. *Ibid.*

The total package of generating electricity from encroacher bush is thus much more advantageous for Namibia than to rely on fossil energy only[50].

A quote from Von Oertzen's (2012) review of the potential of renewable energy in Namibia summarises the industrial-scale energy value chain of encroacher bush best:

"… Namibia's invader bush represents a significant and sustainable biomass energy resource. In addition to being a valuable and potentially sustainable energy crop, the use of invader bush could generate thousands of long-term jobs in rural Namibia. Power plants fuelled by biomass from this indigenous resource would have electricity generation characteristics similar to traditional coal-fired coal plants. Bush-to-electricity power plants can serve as base load and mid-merit power plants, which are dispatchable on demand."

"Value chains focussing on the processing of biomass in rural areas create new jobs, and new local business opportunities, while ridding rangelands from bush infestations. In addition, decentralised power production can contribute to further electrify rural Namibia, thereby creating new activities and opportunities that may also slow rural to urban migration. Few national opportunities offer so many value-adding propositions as the sustained and environmentally sensitive use of the country's invader bush resource does.… In this way, Namibia's renewable energy potentials, and in particular its bush resource can be utilised to make a meaningful contribution to development."

Currently, the predominant sentiment amongst potential biomass users is that economic "pull" factors discourage large-scale energy generation from bush biomass and that no amount of production "pushing" and availing of appropriate technologies (which exist in sufficient measure in the world and in Namibia, too) will encourage land users to utilise their encroacher bush for the generation of electricity. This may change soon as the Electricity Control Board of Namibia (ECB) has drafted rules that determine the feed-in tariff of renewable energy, including a price schedule[51]. According to this schedule, suggested feed-in tariffs for biomass-derived electricity vary from N$1.23/kWh (5 MW plants) to N$2.03/kWh (500 kW plants), which is about 10% higher than those for wind-derived energy but about 35% lower than solar energy tariffs. The proposed tariffs appear to be uneconomical compared to the LCOE mentioned before. It was impossible to establish whether the 12 "rules" associated with the price schedule will be sufficient to "pull" renewable energy generation forward, as hoped. This is perhaps the most urgent assignment for the De-Bushing Programme, to assist the ECB to calculate feed-in tariffs that stimulate the generation of renewable energy and do not deter it. In all probability, the Ministry of Mines and Energy (MME) will also have to be involved in these negotiations.

NamPower has expressed interest in co-firing coal-fired power plants with biomass from encroacher bush because of its availability and competitive energy generation costs. Coal-fired power plants burn high-grade anthracite coal with an energy density of 26 MJ/kg. In comparison, wood contains only 17-19 MJ/kg. At the moment, NamPower needs about 250,000 tons of anthracite a year at a cost of N$1,750/ton of which about half is for transport. Namibia's largest coal-fired power plant, Van Eck in Windhoek is currently being refurbished to accommodate co-firing with wood products and the first unit was commissioned in September 2014. It would need about 35% more green coal than anthracite if only torrefied biomass is burned or 10% more green coal if it is co-fired. Only thorough tests will establish the

50 : It is outside the scope of this baseline study to discuss other sources of renewable energy such as solar and wind power, of which Namibia has even more substantial capacity than of encroacher bush.

51 : GOVERNMENT OF THE REPUBLIC OF NAMIBIA, 2014. *Renewable Energy Feed-In Tariff Rules.* Draft (August 6, 2014) legal document, Electricity Control Board, Windhoek, Namibia.

proper ratios. NamPower Van Eck is also prepared to test-burn other wood products and economics would determine which products are used. Wood has the advantage that it does not need to be imported and valuable foreign exchange remains in the country's coffers, and the disadvantage of a lesser energy density.

Initially, NamPower planned only a single, centrally-located 20 MW biomass plant. Such a plant would devour enormous quantities of wood and have to be serviced by a constant and guaranteed supply of biomass fuel for a long period of time (e.g. by a 20-year fuel supply agreement). This would present a huge transportation challenge and appears a big ask for a wood-harvesting industry that is still in its infancy in Namibia, with individual suppliers (livestock ranchers) that are widely dispersed, each one with a relatively small supply of wood; the harvest of which is not the supplier's first priority, and long transport routes. Not even the Kudu gas field, NamPower's prime power supply option, can guarantee a 20 year supply of gas as its current reserves are estimated to last for only 15 years (highly dependent on extraction rates, of course). Therefore, NamPower is also considering the development of several smaller (5 MW), more dispersed (decentralised) biomass plants in close proximity to supply areas and suitable grid connections. This appears a more appropriate option for Namibia[52] that may initially be more expensive in capital outlay, but more successful at supporting a sustainable bush harvesting industry based on individual producers or, possibly, wood cooperatives. In its "Encroacher Bush to Power" (EBtP) project, NamPower considered a 5 MW biomass plant near Otjiwarongo in partnership with the Cheetah Conservation Fund (CCF) in addition to two larger biomass plants, of 20 MW each, near Otjikoto sub-station and at Ohorongo's cement factory[53]. The EBtP study found that biomass energy would have beneficial effects on water, air quality, biodiversity and waste compared to conventional coal-fired power plants, while the heat generated in the Ohorongo biomass plant could be channelled to the cement kilns.

6.3.2 Torrefied biomass

The EBtP study considered a new technology for Namibia, the torrefaction of bush biomass to yield "green coal". Green coal is a versatile product that can be used, amongst others, to co-fire coal-fired power plants. During torrefaction of wood, mild-temperature pyrolysis evaporates moisture and volatile compounds (e.g. tar, H_2, methane gas) to densify the remaining organic matter into "bio-coal" or "green coal" that is stable and does not rot. Mass loss of biomass during torrefaction is typically 30-50% but energy loss only 10-20%, thus torrefied biomass is an energy-dense, superior fuel for combustion and gasification, easy to transport and to store. It has nearly the same energy density as anthracite, viz. 24 MJ/kg. It thus overcomes some of the logistic constraints associated with wood.

In a recent development, "Greencoal" of Mr. Gershon Ben-Tovim near Omaruru is using about 20,000-25,000 tons of encroacher wood to produce about 10,000 tons of torrefied, coal-like biomass annually. NamPower has trialled a small amount (60 tons) of this biofuel at Van Eck power station but would need 1,000-2,000 tons to run proper tests. Early indications are that Greencoal's extremely high ash content may be a challenge to the furnaces at Van Eck and that further testing is needed before production could be up-scaled. Since wood's natural binders (resins and gums) burn off during torrefaction, Greencoal Omaruru used clay as a binder. In addition, a tractor-drawn wood chipper picks up a lot of soil and dust during the bush harvesting process. Some industry insiders think that the high ash content of

52 : STEAG ENERGY SERVICES, 2013. *Ibid*.
53 : SIMS, K., 2012. *Prefeasibility Study for Biomass Power Plant.* Environmental Screening Report, WSP Environment & Energy South Africa, Bryanston, South Africa.

first-harvested wood is inevitable in Namibia and that the ash content of the second cut (i.e. bush re-growth) will be considerably lower[54]. They also think that the ash and slag removed from plant burners could be used as a fertilizer in the field to encourage more wood growth. Greencoal's pellets were also too small and fell off NamPower's conveyor belts, but these technical problems can be expected during the development process and are not insurmountable.

If the production process of green coal proves feasible, industries that consume much heating energy such as MeatCo's abattoirs and the Namibia Breweries, may be interested in it to direct- or co-fire their industrial combustion chambers. It may also become an energy source for the multitude of mines arising in or near the Namib desert, far removed from the source of biomass as such, and even for export regionally and overseas. A problem generally plaguing products made from Namibian encroacher bush and destined for export to Europe is their high ash (mineral) content. Often, European quality standard (DIN in Germany, EN Europe-wide) limits for content of total ash, sulphur, nitrogen, chlorine, arsenic and mercury are exceeded, potentially limiting sales to industries for which such standards are not essential, e.g. industrial power generation. Stringent European standards guarantee the end-user that human health and equipment integrity will not be compromised by the certified product. Where the end-user is an individual or a small group of people (communities such as churches, schools, the army, etc.), uncertified products are basically unmarketable or at an extreme price disadvantage.

6.3.3 Some industry-specific challenges

Some experts think that the excessively high level of especially the toxic heavy metals in wood ash may be related to the indiscriminate use of arboricides of dubious quality. A detailed research proposal to investigate the residues left in meat and milk due to the use of certain arboricides was made to the Meat Board of Namibia, custodian of meat marketing, in 2011 but was not taken up. The De-Bushing Programme might do the meat industry of Namibia good by picking up this trail and investigating the safe use of arboricides, for whose active ingredient a detailed material safety and data sheet is available but not for its adjuvants.

To facilitate communication and information exchange between the various stakeholders in the encroacher bush and biomass sectors, the De-Bushing Programme initiated various industry working groups. One, the Namibia Biomass Producers' Group, facilitates better cooperation and increased trust between stakeholders in the bio-energy sector and investigates policy interventions that help turn current challenges to Namibia's electricity sector into socio-economic growth opportunities. It could also assist NamPower to obtain the tonnage of wood products needed to run proper evaluation tests of these wood products in energy generation.

However, is energy from bush biomass a silver bullet for Namibia's looming electricity shortfall? Conservatively calculated, if only half of the 75% of Namibia's land surface affected by bush encroachment (see section 5.1) - roughly 31 million hectares - yield 15 tons of dry wood per hectare[55] and only half of this is extracted for electricity generation, 233 million tons of wood are extracted[56]. Converting this wood with an energy content of 5 kWh/kg to electricity with an efficiency of 30-60%

54 : BRUWER, J., 2014. Park land management as an indigenous tool to restore degraded land and the opportunity offered by an associated metrics-based certification mechanism. *Proceedings* 18th Namibian Rangeland Forum p. 13, Gobabis, Namibia.

55 : Yield estimate from HONSBEIN, D., C. PEACOCKE & D.J. JOUBERT, 2009. *Incentive Scheme for Invader Bush Management: A Cost Benefit Analysis*. Consultant's report, Windhoek, Namibia.

56 : In comparison, Zimmermann & Joubert (2002) estimated that the average dry mass of wood from encroacher bush on 260,000 km^2 is 5 tons/ha or 135 million tons in total.

yields 350-700 TWh of electricity (plus a lot of heat, which could also be utilised). Thus, the electricity potential of the current bush crop is enough to meet Namibia's total power demand (2011 = ± 20 TWh) for 18-36 years and is equivalent to a century's worth of electricity supply fed into the national grid by NamPower (2010/11 = 3.91 TWh). Bush energy is therefore an immense energy resource for Namibia and bush-to-energy projects need not worry about "sustainable bush harvesting" or bush farming (i.e. being able to harvest the same area of bush repeatedly). Bush stumps left over after harvesting could indeed be killed off for the sake of rangeland rehabilitation.

6.4 Energy value chains: Domestic scale

The use of wood (not necessarily all from encroacher bush) to generate energy for domestic purposes is huge in Namibia. Wood derived from Namibia's savannas has been used for domestic purposes (cooking, heating, lighting, dwelling construction and dwelling protection, e.g. fences) since time immemorial. It is very difficult to quantify the amount of wood used for domestic purposes but is estimated by some industry experts to easily be Namibia's biggest energy consumption sector after fossil-fuel derived energy.

6.4.1 Lumpy firewood

The 2009/10 Income and Expenditure Survey showed that more than 50% of all Namibian households still depend on wood for cooking and slightly less than half of households on wood for heating. Much of this wood derives from dead trees and only a small proportion derives directly from encroacher bush. This means that, even though wood consumption is high, its impact on encroacher bush is low. It has been estimated[57] that about 440,000 tons of wood are used in the informal firewood sector in Namibia each year. This includes collection of firewood for own use in rural areas. Only about 10-20% of this produce is sold, mainly informally along the roadside or directly from wood gatherers.

The same industry expert estimated that the formal firewood sector consumes about 45,000 tons of wood per year. Namibia's poorest households are also those that can least afford to buy manufactured wood products such as logs from compressed wood chips to replace real wood for heating and the preparation of food. Up-market demand for barbeque fuel in Namibia is for real wood (the traditional braai fuel) or briquettes. Therefore, most manufactured wood products are exported. In South Africa for example, demand for manufactured wood products for recreational purposes (especially charcoal briquettes for braaiing) is huge. The Cape, due to its cool climate, also has a huge demand for wood chips logs for indoor heating. Distance to market of this relatively bulky, low-value product has so far prevented manufactured wood logs from becoming an export hit.

6.4.2 Chip-wood products

In addition to lumpy firewood, products manufactured from wood chips are sometimes classified as "domestic-scale" energy products because this is the way they started off. Biomass briquettes and chip wood logs were originally developed for heating homes but have some options of industrial application, mainly in small-scale operations. However, their production potential in Namibia is limited. Two Namibian examples of this value chain are the "BushBlok™" and "Ecolog".

57 : VO Consulting, 2014, pers.comm.

One of the earliest projects in the country that tried to add significant value to encroacher bush, the BushBlok™ project of the Cheetah Conservation Fund (CCF), started in 2001. It utilises wood accumulating when bush-encroached rangelands are thinned to create a more open savanna; the preferred habitat of the previously-endangered cheetah, which hunts by sight and needs a relatively open field of vision. The wood is harvested, chipped and compressed into briquettes at a recently re-tooled factory in Otjiwarongo. An extrusion press uses heat and pressure to bond wood chips tightly together without additives, resulting in a high-calorific fuel that is classified as smokeless (even though consumers complain of excessive smoke). In a 2007 study, the fully mechanised skid steer harvesting process was found to be most economical, although a semi-mechanised process (workers equipped with mechanical bush harvesters) was acknowledged to be a good compromise between cost and employment creation. One of the objectives of this project is to be a role model for encroacher wood use. However, despite current production levels of 7,500-10,000 tons/year harvested from 570 hectares, it is by own admission over-capitalised and not yet profitable.

Some private farmers are also experimenting with turning manufactured wood logs into a profitable business. The partnership of Heiko Maier and Dr. Arthur Baggot-Smith (Omariru Biomass Investments, OBI) has started bush thinning along ecological guidelines on their farm near Okahandja (estimated 2013/14 harvest: 10,000 tons of wet wood), turning the harvested bush into a manufactured wood log called the "Ecolog", which is used locally and exported for domestic heating. They have recently moved their operation closer to Otavi to supply Ohorongo Cement with 20,000 tons of wood chips (not processed into Ecologs) per year to fire its cement kilns, in reaction to Energy for Future's wood procurement from third parties. If successful, they can certainly be classified as "industrial scale" operators henceforth. This is a perfect example of the "pull" factor exerted by a proven demand for wood products at a reasonable price for both the producer and the consumer of this product, unconstrained by regulations designed for a different sector and purpose but causing co-lateral impact with unintended consequences (e.g. Namibia's energy policy which entrenches monopolies). This "pull" factor is causing up-scaling of domestic energy activities to industrial level.

Other potential applications of chipped wood products include biomass pellets. These are in huge demand overseas due to promotion of alternative energy, especially in co-firing of coal-fired power plants, but no pellets have thus far been produced in Namibia. A lot of study has been invested in the thermo-chemical conversion of wood and chipped wood by pyrolysis and gasification to produce electricity and chemical by-products such as woodgas, tar, fertiliser ingredients, etc.[58] The immediate application was to be at the farm level (i.e. for domestic purposes) although this technology is easily up-scalable. The energy would have to be fed into the national electricity grid and is thus constrained by the same institutional impediments discussed in a previous section while the chemical by-products alone do not make such a plant profitable. Thus, while such processing of wood is technically feasible, no such plant is operational in Namibia. Some of these processes that started off for "domestic" purposes certainly have industrial potential and are currently or potentially transiting to industrial scale due to rapid developments in the biomass energy sector.

58 : HONSBEIN, G., 2009. The influence of thermo-chemical conversion on rangeland condition. Proceedings 13th Namibian Rangeland Forum p. 9, Neudamm Agricultural College, Windhoek, Namibia.

6.5 Value chain: Building materials

Raw fence droppers, poles and straining posts are commonly made on Namibian farms for own use as fencing material and for informal sale from farmer to farmer. If made from the wood of Terminalia or mopani trees, they are inherently termite-proof. Supply and quality varies depending on the extent of bush control activities on the farm. For example, the Ombili Foundation (Grootfontein district) is currently producing thousands of raw 1.2m-droppers for on-sale at N$2.50-3.50 apiece, which Pupkewitz Megabuild[59] has indicated is a very attractive price to them. However, no-one could estimate the quantities of droppers, posts and poles made or amount of encroacher bush harvested for this purpose.

Picture 9: Farm-made, raw fence droppers are by product of bush control

Picture 10: Poles and fence hangers ("droppers") made from the encroacher bush/tree *Terminalia sericea*

Although there is a huge demand for raw, farm-made droppers, large agricultural input suppliers do not buy them up for re-sale to other customers. Poles are not treated against decay and termites and are not normed to any standard, which might expose input suppliers to claims for damages if they sell raw droppers[60]. However, Pupkewitz Megabuild has exploited a market niche and sells raw fence droppers

59 : Pieter Liebenberg (Procurement Manager: Pupkewitz Megabuild), pers.comm.
60 : Kobus Jacobs (CEO: Kaap Agri Namibia), pers. comm.

without guarantee at its Katutura, Windhoek branch only, as part of its Low Cost Housing Project since 2008. They are used primarily as building material in shack and yard construction in high-density, informal residential areas[61]. About 1,500 poles of 75-100 mm diameter have been sold monthly from the Katutura outlet and many thousands more to its contractors. This number could not be quantified because of the bulk billing system Megabuild uses for contractors. Pupkewitz Megabuild would like to expand this project by procuring more poles and other relevant wooden products such as dropper edgings for bedding borders, push-in panels, etc. locally[62].

Picture 11: Bedding edgings made from droppers off-cuts

Picture 12: Independent SME operator drilling holes at pre-determined distances

61 : Pieter Liebenberg (Procurement Manager: Pupkewitz Megabuild), pers.comm.

62 : See "The Pole Yard: Garden Products Catalogue 2014" for ideas and specifications of wooden products commonly stocked by Pupkewitz Megabuild, Build-It and similar retailers (available from MegaBuild).

Picture 13: Bagged, dyed decorativemulch made from bark

Other than farm-made fence droppers, wood from encroacher bush is not sold in the formal market as building material. Theoretically, a variety of chip and press wood products could be manufactured from Namibian encroacher wood, which is a hardwood. However, several factors have conspired against the establishment of such an industry which, until a short while ago, was attempted by Scania Kitchens in Windhoek. Probably the biggest problem is that no norms and standards exist to ease the logistics of the manufacturer to procure a steady supply of wood of desirable and uniform quality. Quality of the wood supplied varies tremendously and all the risk of procuring the wrong type is with the manufacturer. Secondly, while Namibian hardwood yields coarse chips of acceptable quality, the resins in the wood make for an uneven consistency of the pressed wood product. Thirdly, the high sand and ash content adds an expensive pre-processing procedure to reduce the ash content of the wood. It is just so much easier and more economical to make chip and press wood products from softwood such as pine, grown uniformly under controlled conditions in huge plantations than to struggle with a highly variable, uncompliant indigenous resource. Others who have tried and given up include Geva Renovations in Windhoek. The De-Bushing Programme might assist in developing norms and supply chains that can feed these latent building materials industries with the assistance of the Namibian Standards Institution (NSI) of the MTI.

In a collaborative project ("NaMiBIND"), post-graduate students of the University and the Polytechnic of Namibia are collaborating with the Leibniz Institute for New Materials (INM) to develop a new type of binder composed of commonly-found raw materials in Namibia, such as Namib sand and hydrocarbons from encroacher *Acacia* bush. Primarily a programme for research-training of students, a commercial product is not envisaged in the near future[63].

63 : Dr. Ingrid Weiss (Head: Biomineralization, Leibniz-INM), pers. comm.

6.6 Value chain: Animal feedstuffs

No formal chains that add value to bush by using it in animal feedstuffs are operational in Namibia. That is primarily because lignin, by mass the dominant ingredient in wood biomass, is completely indigestible, even by the microbes in the rumen of cud-chewing animals. The only digestible matter in bush biomass comes from unlignified twigs and branchlets, from the leaves, fruit and seeds attached to branches and from whatever sap the bush biomass may contain. Some of these saps may contain anti-nutrients, e.g. alkaloids (toxic) and tannins (make dietary proteins indigestible). The scientific literature is unambiguous that bush fodder with a high wood (lignin) content is unsuitable for animal fodder, even as drought (i.e. maintenance) fodder and even when it is made from a relatively flimsy shrub as *Rhigozum trichotomum*[64], generally regarded as less nutritive even than wheat straw. Only if the outer perimeter of a bush canopy, containing its unlignified branchlets and most leaves, is harvested does the resultant bush feed have meaningful nutritive value.

To increase the proportion of digestible material in bush biomass would require either that the outer layer of a bush canopy (where most of the unlignified twigs and leaves associated with a woody plant's growth points are located) is peeled off separately and used for fodder purposes while the central part is used for energy, or that only very young and small bush and bush re-growth is harvested for feed. These methods are used by WesVoere/WESagri, a company in Thabazimbi, South Africa that makes the popular "Boskos" and "Wes Horse" pellets, which contain only 30-35% bush matter while the rest, 65-70%, is concentrate feed. This makes the imported pellet more expensive in Namibia than a lucerne pellet, which is the ultimate roughage (i.e. non-concentrate) feed that is also imported from South Africa.

WESagri pellets are available since 1992 in a number of formulations that contain 10-16% crude protein (an absolute minimum would derive from wood), 25-35% crude fibre (most of it would derive from wood) and standard concentrations of the major minerals. The marketing campaign emphasises the organic origin of the pellet and its contribution to bush control and maintaining nature's equilibrium. Pellets are recommended as drought fodder for ruminants and high-fibre fodder for wild game animals, zoo animals and horses. Ingeniously, the relatively high and potentially harmful tannin content of the pellet is ignored in the "Boskos" advert while being touted as anti-oxidant, pathogen-controlling, bloat-preventing cardio-protective polyphenols in the "Wes Horse" advert.

Yet reports that farmers are using bush biomass as drought, emergency or survival ration are piling up. This despite the fact that most Namibian encroacher bush species abscise their leaves when experiencing drought stress, thus reducing the nutritive value of bush fodder even more. Either it is a matter of animals being able to survive underfeeding with bush fodder long enough to just outlast a drought, or bush fodder is so diluted and prepped up with highly digestible concentrate fodder that the bush matter is really only a filler; ballast to physically fill the rumen but does not contribute significantly to animal nutrition.

A chemical analysis of bush silage made from *Acacia mellifera* near Windhoek is available that contains 7.2% crude protein and is 54% digestible on an "as is" basis with 43.7% moisture content. It was fed successfully to dairy cows[65]. Another farmer claims to have survival-fed 1,000 head of cattle through the

64 : MOORE, A., 1989. *Die Ekologie en Ekofisiologie van Rhigozum trichotomum (driedoring).* Ph.D. thesis, Botany Department, University of Port Elizabeth, Port Elizabeth, South Africa.
65 : Krumneck farm of Mr. G. Woker.

recent drought with the loss of only 12 cattle, on bush fodder costing N$0.57/kg[66]. A company founded by Namibian behemoth Olthaver & List's Organic Energy Solutions developed a bush-based feed with 8 MJ ME/kg and 13% dietary protein that could be used in feedlots to feed growing ruminants. It also contains Namibia Breweries' expended brewer's yeast, a very palatable ingredient that stimulates appetite. Such a feed may become relevant if MeatCo's intention to erect several beef feedlots in Namibia to grow out the weaner calves no longer easily exportable to South Africa realizes.

In all these bush feeds, bush is likely only a minor ingredient serving to massage the rumen and gut of animals with plant fibre rather than supply significant nutritive value to the feed. The inevitable question is if the substantial cost of harvesting and milling bush feed justifies its inclusion in least-cost rations. The De-Bushing Programme would do well to follow some of these case studies up to determine their nutritive and economic merit and identify the key ingredients that made the case a success. It could then be trialled further at one of the many research farms in Namibia.

6.7 Employment opportunities

Considering all the above value chains of encroacher bush, inevitably the question arises: How many people are employed in the various value chains of encroacher bush? Such information, summarised in the table below, is extremely difficult to obtain since no-one gathers these statistics and needs to be verified, but indicates roughly the current employment level of these industries.

Table 6: Current employment in industies

Operation	**Employees**
De-bushing farm workers	250 – 1,000
Charcoal industry	5,500
EFF	150
CCF	15-20
OBI	15-20
Building materials	5
Animal feedstuffs	10
Total	**> 5,950**

It appears that – currently - the largest employment occurs in the sector that harvests encroacher bush rather than in the sectors that convert it into energy, building materials and animal feeds. But this situation can change dramatically if bush value chains grow and diversify. Such expansion will in turn necessitate further employment in the de-bushing/harvesting sector to meet the increased demand. Similar growth can be expected in a secondary, supporting sector, e.g. transport, logistics, supply/rental of equipment etc.

From anecdotal observations it appears that most employees are male, but again this needs verification. Organisations with experience in labour and employment surveys, such as the NAU-affiliated Agricultural Employers' Association, the National Employers' Federation or the Namibian Statistics Agency could be approached by the De-Bushing Programme to conduct a proper labour or employment survey.

66 : Mr. A. Goetz, Outjo district.

7. Recommendations

Many specific recommendations are mentioned in the text of the baseline study at the relevant section. However, some general recommendations remain to be pointed out.

7.1 General recommendations

1. Several leading rangeland scientists and ecologists in Namibia expressed reservations about the intent of the De-Bushing Programme. Their major concern is that economic objectives (e.g. sustainable bush harvesting) will override agro-ecological objectives (e.g. sustainable rangeland management). One of the ways in which to allay these fears is to re-name the programme the "Bush Control" programme, implying that encroacher bush is sensibly controlled, rather than "de-bushed" which actually implies the total eradication of bush. This is certainly not the intent of the programme and its current name is thus an inaccurate reflection of its main objective.

2. The Soil Conservation Act of 1969 impacts bush control activities only indirectly but applies only to Namibia's commercial farming areas and not to its communal areas. This Act gives the Minister of Agriculture wide-ranging powers to introduce measures such as subsidies and targeted support to protect and improve the soil, vegetation and water resources, to withdraw land from cultivation and grazing and to encourage land users to apply crop and grazing rotation and soil-stabilising measures. The Namibian Government needs to be convinced that farmers in communal areas also deserve the kind of support foreseen in the Act for commercial farming areas, lest they complain – rightly! - of being discriminated against.

3. Any new industry (e.g. utilisation of encroacher wood) benefits if it is structured, adequately represented at central planning fora and enjoys infant industry promotion and protection support measures. While capitalism is all about taking risks, emerging capital industries are more likely to fail if they are left with all the risk themselves, especially in a small country as Namibia with a limited internal market and purchase power. In building a new industry, Government and capitalist entrepreneurs are partners and not adversaries, or policemen and milk cows. If some of the risk, e.g. research and development, targeted procurement or initial subsidisation is carried by Government, sustainable industry development is more likely. After establishment, initial support measures can gradually be phased out and the maturing industry can be left to its own devices (within a regulatory framework). Building an industry requires a long-term commitment and strategic planning that includes all stakeholders. The De-Bushing Programme would do well to promote this understanding amongst policy- and high-level decision-makers.

4. Few agro-technical approaches hold as much promise for Namibia's land reform programme as control of encroacher bush followed by systematic improvement of the grass sward and the land's grazing capacity. If it is indeed true that bush encroachment can reduce the grazing capacity of farmland to as little as 10% of its original productivity, then sustainable bush control and grazing improvement can also improve the grazing capacity by as much, or nearly as much. This means that land owners would need much less (rehabilitated) land in future to maintain their current level of production and standard of living. Theoretically, much more farmland should become available for redistribution to previously disadvantaged Namibians who want to and can farm productively.

➔ Perhaps this principle can be used to make the resettlement process more successful: It is said that the administrative delay between MLR buying a farm and beneficiaries actually being resettled on it

can take years. This administrative "pause" should be used (guided by the De-Bushing Programme and the NRMP&S and using labour-intensive SMEs) to regenerate the productive capacity of the procured farm, before the settlers come. Subjecting every farm purchased by the Ministry of Land and Resettlement (MLR) for resettlement purposes to rigorous bush control and systematic grass sward improvement prior to resettling people on it, means that more people can be resettled on the same land and have a better chance of becoming productive farmers. Once the beneficiaries arrive on the rehabilitated land, they should be assisted by intensive training and mentoring to help them make a success of farming. A farmer support programme is already implemented by the GIZ on behalf of the MLR, i.e. one development initiative can take over where the previous one ended.

5. The Programme literature speaks of trials in three pilot regions. Where could these be sensibly located?

➔ At least one of these pilot sites should be in the north-eastern communal areas where woodiness is at its highest in Namibia. But this site would be remote and poorly served by appropriate infrastructure and services; difficult to operate successfully. It should therefore rather be "next door" in the closest well-wooded commercial area with superb infrastructure and services and every chance of success, for example in southern Oshikoto region. The process that could be trialled here is value addition by making charcoal in commercial and communal farming areas.

➔ A second pilot site should trial how encroacher bush can be turned into biomass energy, profitably because this is the value chain with the most potential (in terms of most value added for the country and most bush removed from the land). The only existing power station in Namibia that is equipped to burn bush and wood products is Van Eck in Windhoek. The surrounding Khomas region has enough encroacher bush to sustain such a pilot.

➔ The third pilot site could be at Ohorongo in the Otjozondjupa region, which also offers existing wood-use and electricity infrastructure. The existing site could be expanded to accommodate a smaller biomass power plant (e.g. a 20 MW plant as envisaged by NamPower) so that the wood demanded by these two industrial plants can be combined and the effect of bush harvesting exponentially increased.

➔ More pilot sites are recommended to achieve better geographical representation (e.g. also in the arid north-western, sandy eastern and dwarf-shrub southern parts of the country), methodology (e.g. one cannot trial burning and chemical control at the same site, simultaneously), better represent various land use systems (e.g. communal areas, conservation areas and forests) and reach more people with demonstration and experiential (participatory) learning.

6. The use of encroacher bush for the generation of electricity/energy on a domestic scale, for building materials or for animal feedstuffs is an ideal case for promoting many small, diverse businesses to exploit the various niches of the market. Some of the small and medium enterprises (SME) will be very successful and grow big over time, depending on their niche and management. The De-Bushing Programme should therefore be the link between potential small enterprises and existing structures and institutions that support SME, such as the Namibian and African Development Bank, SME Bank, Namibian Chamber of Commerce and Industry, Centre for Enterprise Development, etc. An important prerequisite for any establishing industry is to quantify the available resource ***reliably*** and the De-Bushing Programme could assist in testing and adapting existing quantitative wood yield methods to determine the precise wood yield at a specific site targeted for industrial intervention.

7.2 Summary of specific recommendations

The following bullet list provides a summary of specific recommendations of the baseline study. Many of these recommendations are based on quantified information that could be included in the M&E system. Specific recommendations are not listed in order of priority but in the order they are mentioned in the text body of this baseline report.

i. Investigate data gaps, e.g. those indicated by "anecdotal" evidence, if relevant.
ii. Stimulate and develop the perception that encroacher bush is not only a "farming problem" but also a good business opportunity; shift mind sets; by means of a concerted public information campaign.
iii. Streamline the policy framework, specifically pertaining to the charcoal/forestry/de-bushing and renewable energy sectors, to address contradictions between different legal documents, grey areas (who is responsible?) and oversights.
iv. Work out a graded approach to bush encroachment that quantifies the extent of the problem, e.g. by converting absolute bush densities into how many more times than normal the area is overgrown with bush and relate this to financial implications, if possible.
v. Quantitatively validate the extent of bush encroachment in Namibia by applied research using modern technology, country-wide. This activity may overlap the intentions of the RCU to have a series of rangeland audits and that of other divisions of the GIZ that are interested in related aspects such as the grass-based carrying capacity of the land (those assisting the MLR, whereas the interest of the De-Bushing Programme is more towards determining the bush density and wood yield of the land).
vi. Assist the Registrar of Agro-Chemicals and Animal Feedstuffs in the office of the MAWF to improve the quality of records kept, to better inform decision-makers and possibly update the relevant legislation.
vii. Investigate methods of rangeland rehabilitation following bush control, especially strengthening of the grass sward/grazing capacity.
viii. Support research trials on encroacher bush control and investigate case studies of successful on-farm bush control, including their proper place in the legal framework and the issue of potential arboricide residues in meat.
ix. Initiate action on De Klerk's (2004) bush encroachment management and containment strategy.
x. Contribute to existing efforts to coordinate and streamline rangeland-related activities such as the proposed Rangeland Coordination Unit under the NRMP&S.
xi. Reduce confusion and friction caused by duplicitous legal documents pertaining to bush encroachment and rangeland management by compiling a comprehensible, user-friendly guide for farmers on which Acts and Policies apply to rangeland management, including the management of bush encroachment, on the farm.
xii. Consider which institution should "house" the De-Bushing Programme and maintain sustainability after end of project. This body would have to be properly constituted, equipped and funded to perform all functions expected of it, including measuring progress in the bush control and wood use sectors.
xiii. Contribute towards expanding existing financial incentive schemes of state and private banks, lenders and development institutions.
xiv. Design a lean but effective M&E system.
xv. Support bush research trials that contribute to our understanding of encroacher bush ecology and its effective, sustainable control.

xvi. Hold trials to test the usefulness of existing quantitative wood yield methods to predict wood yield accurately and reliably under local conditions; on site.

xvii. Re-configure the "De-Bushing Advisory Service" to become more of a networking and facilitation service that boosts the capacity of existing extension services but also offers demand-driven training courses (preferably with national accreditation) in matters of production (including bush control) and value addition to encroacher wood.

xviii. Link de-bushing and bush value-adding SMEs to the SME support sector.

xix. Strengthen the existing institutional framework by enabling existing institutions to oversee their industries or sectors more effectively (e.g. NCPA).

xx. Follow-up on the environmental, social and institutional recommendations of the "charcoal report" of Diekmann & Muduva (2010).

xxi. Attend to the challenges identified by the charcoal industry itself.

xxii. Investigate ways to strengthen the 3rd part wood purchase scheme of Energy For Future.

xxiii. Act on suggestions on updating and modernising the regulatory framework of Namibia's energy sector (Von Oertzen 2010 and 2012).

xxiv. Help the ECB design REFIT prices and rules that stimulate conversion of encroacher bush into biomass energy and do not deter it.

xxv. Investigate whether residues of arboricides occur in food products produced on chemically treated Namibian farmland.

xxvi. Facilitate communication and information exchange and networking by means of the various working groups.

xxvii. Develop norms (e.g. for fence droppers and posts) and supply chains that support and feed the latent building materials value chains, possibly in collaboration with the NSI.

xxviii. Investigate case studies of using bush as drought/emergency feed.

xxix. Approach organisations with experience in labour and employment surveys, such as the NAU-affiliated Agricultural Employers' Association and the National Employers' Federation, to conduct labour or employment surveys.

xxx. Inform policy- and high-level decision-makers of the need for a long-term commitment and strategic planning that includes all stakeholders to build an industry.

xxxi. Use the administrative delay in the resettlement process to regenerate the productive capacity of the land, before beneficiaries are physically re-settled, using labour-intensive SMEs. Hand over to the GIZ FSP programme to further assist resettled farmers post-settlement.

7.3 Quantification of Programme indicators

Based on the detail explained in the text, Programme performance indicators are quantified in the following table.

Table 7: Programme performance indicators

Question/Indicator	Baseline summary/figures	Recommendation(s)	Text ref.
Scope			
Impact of bush encroachment on agricultural output (development over past decades, current figures, impact on farm level)	Bush encroachment reduces grazing capacity to 1/3rd to up to 1/10th of the original capacity; increasing exponentially Economic losses estimated at N$1.6 billion annually in foregone meat production Farmers report much more grass after bush control, but not much better quality grass	Impact can no longer be quantified as there is little non-impacted rangeland left, but impact can be assessed in reverse by measuring improvement after bush control. Combine with quantified baseline assessment, M&E system, rangeland audits, etc.	5.1
Scope of bush encroachment in Namibia (area size, number of households/farms) incl. assessment of data quality	26 million ha (De Klerk, 2004) 62 million ha (this report) 65,000 communal households and 6,283 commercial farmers and their employees (De Klerk, 2004) Much of data quality is poor (too much expert opinion and too little real measurement) and outdated	Requires a comprehensive overhaul, review and update by country-wide quantified survey using modern remote sensing technology and expansive field-based ground trothing.	5.1.1 6.4
Extent of past and current de-bushing activities (area size, no of farms/households, no of involved organisations/harvesters, activities of the MAWF/DoF)	Nearly 128,000 ha bush-controlled annually (but some of these ha may be treated a 2nd/repeated time) on unknown number of farms/households Bush control mostly implemented by unquantified number of individual farmers, NYS, 2 aerial sprayers, several smaller wood harvesters (see text)	The overhauled, quantified assessment referred to above should be expanded to be able to track annual changes in bush density. This function can indicate the area of bush control. If overlain with GIS, the number of commercial farms can also be established, but not in communal areas or workers involved.	5.2
De-bushing methods (comparison of methods incl. costs taking into consideration economies of scale, bush type and density)	Chemical, manual, mechanised and biological control methods as described and compared in earlier "Local Assessment Study" (App. IV)	Update survey and costs occasionally (as part of M&E?); integrate into DSS. Facilitate, organise up-scaling of supply side. Induce mind set shift from "problem" to "opportunity". Information dissemination and training.	5.2 App. IV
Potential pilot areas for de-bushing projects (according to geographical	1. Southern Oshikoto (good infrastructure, high bush density) 2. Khomas (Van Eck, high bush density)	Biomass conversion to electricity enjoyed priority in recommending these sites as it has the biggest "pull" factor to stimulate	9.1

Question/Indicator	Baseline summary/figures	Recommendation(s)	Text ref.
criteria incl. assessment of the respective value addition potential)	3. Otjozondjupa (Ohorongo, existing off-take and grid connection) 4. Others should be developed in NCA, arid south and north-west, sandy east, in ecologically and socially suitable sites	value addition to encroacher wood. Alternative sites based on other priorities. Pilot areas to address/demonstrate up-scaling of de-bushing, wood supply, logistics chain, value addition chains, marketing, etc.	
Policy and Institutional Framework			
Availability of national policy on bush encroachment a/o de-bushing	No specific policy on bush control, but it is an integral part of the NRMP&S (2012) A bewildering variety of other regulations and acts impact bush management with little clear application to the on-farm situation	Rather than make a new policy, strengthen NRMP&S to satisfy requirements of de-bushing and value-addition. Harmonise other regulations and acts that influence bush management (Forest Act, Environmental Act, and Soil Conservation Act.)	6.2
Availability of national strategy/action plan on bush encroachment/de-bushing	SEP in DoF, but it appears without implementation strategy Bush control is part of the 2013 work plan of the NR&BEF Indirectly contained in "Strategy" part of NRMP&S	Coordinate development of such a plan with the to-be-formed RCU. Plan should emphasise info dissemination, training, value addition, market development.	5.2.2 (p. 26) 6.1
Availability of a coordinating body on national level	The Programme is steered by NPC and closely linked to four line Ministries (MAWF, MET, MTI and MME). Implementation should be coordinated with NR&BEF and the NAU-housed RCU, which should be functional before the end of 2014	Ensure sustainability of project steering after project end. Amalgamate NR&BEF and RCU. Join newly-constituted body; ensure that Programme objectives get proper emphasis, incl. wood harvest, utilisation & marketing.	6.1 6.4
Promotion and Support Schemes			
Availability of national support programmes a/o incentive schemes for de-bushing and rangeland management (alternatively list of coordinating stakeholders/institutions)	None from GRN Financial incentives to de-dush by AgriBank and FNB only	Integrate any bush control incentives into wider rangeland management and rehabilitation incentives, to be worked out by RCU. Engage SME development sector, NYS. Identify and develop markets for encroacher wood products.	6.3

Question/Indicator	Baseline summary/figures	Recommendation(s)	Text ref.
Availability of financial support programmes and products for de-bushing and rangeland management (government and/or private sector, incl. level of utilisation)	AgriBank's de-bushing loans FNB AgriDivision loans for bush control	Ensure existing financial incentives include ***all*** bush control methods incl. charcoal Consider FNB's plan to avail N$100 million to their loan scheme. Align farmers' expressed needs for financial incentives (e.g. subsidies on arboricides, labour) with GRN policy of "no subsidies".	6.3.1 6.3.2
Availability of Advisory Services and their level of utilisation (list of support packages; number of users from commercial and communal farms)	None specifically on bush control and wood utilisation DEES, FSP and MBN mentorship scheme all include bush control (but not wood use) in their regular advisory services DEES operates country-wide FSP works in resettlement sector MBN mentorship scheme serves communal MeatCo clients	Wide range of recommendations to improve effectiveness of existing services, add new dimensions (on bush control, wood use and operations), etc. Address attitude & knowledge, stimulate in-novation, and facilitate upscaling supply&demand.	7.1 7.2 7.3 7.5
Bush Expert Decision Support System (level of utilisation and financing strategy)	Polytechnic's DSS EcoRestore LandPKS	Help Polytechnic to make their system operational again (software failure). Train MAWF DEES in use of DSS.	7.4
Availability of a monitoring system to capture de-bushing activities and their success (by MAWF or other stakeholder)	None	Integrate de-bushing and wood use M&E with RCU rangeland audits and M&E efforts.	6.4
Value Chains for Bush Biomass			
Availability of coordinating body or institutional arrangement for the de-bushing/harvesting sector (list of previous/current efforts)	None for wood use NCPA for charcoal sector Of the three national farmers' unions, the NAU is best equipped to coordinate the activities of producers and assists the NCPA with a secretariat, but does not coordinate the charcoal (or wood use) sector	Coordinate and strengthen activities of wood users and industry associations e.g. Biomass Producers' Group. Strengthen NCPA institutional and administrative capacity. Support RCU to-be-formed.	6.1 8.1.2 8.1.4
Previous trials of value addition opportunities in Namibia	NamPower: limited testing of co-firing with bush biomass Pre-industrial tests of pyrolysis processes IPP: bush-fuelled 250 kW generation plant	Charcoal trials needed to pilot new approaches and new technology. Assist Greencoal to overcome production	8.1.4 8.3 pp. 56

Question/Indicator	Baseline summary/figures	Recommendation(s)	Text ref.
	CCF BushBlok, OBI Ecolog, Greencoal Omaruru	hurdles; same with NamPower co-firing tests.	8.4.2
Current value addition undertakings (incl. statement on commercial and organisational viability)	Charcoal: 60,000 – 158,000 t/year exported Ohorongo/EFF: 85,000 t/yr but only 40,000 t/yr realised Wood products for domestic or industrial energy: about 30,000 t/year – some respond to EFF 3rd party scheme Firewood: ± 500,000 t/yr (only some from encroacher bush) None/negligible: industrial and domestic energy generation Building materials Animal feedstuffs	Optimise, stimulate and coordinate (as discusses in sections 8.2, 8.3 and 8.4) Address limiting factors: disorganised and small-scale supply side, demand side too little coordinated, new markets and value addition processes can to be developed, ensure condusive regulatory framework, and improve capacity and competence.	8.1 8.2.1 8.2.2 8.4 8.3 8.5 8.6
Potential value addition opportunities under consideration	Most urgent with largest potential is to define REFIT tariffs that stimulate biomass energy generation Ohorongo/EFF: expand to 85,000 t/yr capacity Many more potentials as explained in text (ch. 8)	Improve institutional capacity of stakeholders e.g. WoodCo, NamPower, O&L Energy, MeatCo, OBI, Greencoal; facilitate and coordinate, identify & develop markets.	8.2 8.3 8.4
Number of individuals (male and female) involved in/employed in value addition activities	Nearly 6,000 workers on farms and in industries (needs to be confirmed, see p. 61). Sex: not known but probably mostly male	Approach Agricultural Employment Association (NAU) and/or National Employ-ers' Federation and/or Namibia Statistics Agency for cooperative employment survey.	8.7

In closing, the much-valued contributions of countless individuals, some of them mentioned in App. II, who availed their knowledge, information, time and effort is gratefully acknowledged. In particular, the guidance of the GIZ De-Bushing Programme Team Leader and assistance of team members is highly appreciated.

APPENDIX I: Essential reading list

DE KLERK, J.N., 2004. *Bush Encroachment in Namibia.* Report of Phase 1 of the Bush Encroachment Research, Monitoring and Management Project, Ministry of Environment and Tourism, Windhoek, Namibia.

INTERNATIONAL DEVELOPMENT CONSULTANCY, 2002. Situation Analysis of the Present and Possible Future Applications of Excess Wood Biomass. Consultant's report, IDC, Windhoek, Namibia.

INTERNATIONAL DEVELOPMENT CONSULTANCY, 2003. *Institutional Structure and Framework for the Bush Utilisation and Processing Industry.* Report for Ministry of Trade & Industry and Ministry of Agriculture, Water & Rural Development, IDC, Windhoek, Namibia.

LEINONEN, A., 2007. Bush Encroachment – the Challenging Resource for the Renewable Bioenergy in Namibia. Wood Chip Production Technology and Costs for Fuel in Namibia. Technical Research Centre of Finland (VTT), Jyväskylä, Finland.

MASAIRE, Edmore, 2014. Rehabilitation of highly bush-encroached land in Ohangwena region and using invader bush as a sustainable resource for livestock nutrition improvement. Project proposal.

Minutes of meeting, 2014. Biomass Fuel Supply Working Group meeting, 24 July 2014.

SCHULTZ, R.W., 2011. *Guidelines to Independent Power Producers.* CBEND Bush to Electricity report, Desert Research Foundation of Namibia, Windhoek, Namibia.

SCKYDE, Arno, 2012. Results of the project appraisal mission for the De-bushing project in Namibia. Agreed minutes.

SIMS, K., 2012. *Prefeasibility Study for Biomass Power Plant.* Environmental Screening Report, WSP Environment & Energy South Africa, Bryanston, South Africa.

STEAG ENERGY SERVICES, 2013. *Study on Namibian Biomass Processing for Energy Production.* Occasional report of STEAG Energy Services GmbH/Transworld Cargo (Pty) Ltd, Essen, Germany.

VO CONSULTING, 2012. *Namibia's Energy Future: A Case for Renewables.* Konrad-Adenauer-Stiftung, Namibia-Angola Country Office, Windhoek, Namibia.

WEISS, Ingrid, 2014. NaMiBIND project report (UNam, PoN, NBIC).

APPENDIX II: Interviews conducted

Name	Position	Date of interview	Topics covered
Sakkie Coetzee Harald Marggraff Danie van Vuuren Wallie Roux	**NAU**: CEO Manager: Commodities Secretariat: Charcoal producers Head: Research	29 July 2014	Extent of bush encroachment, de-bushing, policies, value chains
Tobias Konzmann	Energy for Future: CEO	29 July 2014	Value chains
Wallie Roux	**NAU**: Manager: Research & Development	30 July 2014	Extent of bush encroachment, de-bushing, policies, value chains
Marietjie van Staden	AgriForum: Editor	30 July 2014	Extent of bush encroachment, de-bushing, policies
Dr. Cornelis van der Waal	Independent consultant	31 July 2014	Extent of bush encroachment, de-bushing, value chains
Cyprianus Khaiseb	**MeatCo**: Executive (Local Markets & Value Addition)	1 August 2014	Extent of de-bushing, policies, value chains
Günther Maartens	Ombili Foundation: Manager	3 August 2014	De-bushing, farm value-adding
Peter Kazmaier Arnold Klein	Agra Ltd: CEO General Manager: Retail & Wholesale	4 August 2014	Value chains, arboricide sales
Pieter Liebenberg	**Pupkewitz Megabuild**: Procurement Manager	4 August 2014	Value chains
Michael da Rocha	Lumber City: CEO	4 August 2014	De-bushing, value chains
Goliath Tujendapi	**Meat Board:** Manager (Trade & Strategic Marketing)	4 August 2014	Value chains
Kobus Jacobs	Kaap Agri: CEO	4 August 2014	Value chains, arboricide sales
Willem Enslin, Willem Groenewald, Frans Holzkampf	Executive members of the Namibia Charcoal Producers' Association	6 August 2014	Charcoal value chains
Frank Detering	Forest Stewardship Council	6 August 2014	Value chains, policies
Joseph Hailwa	Deputy Director: **Forestry**	7 August 2014	Extent of bush encroachment, de-bushing, value chains, policies
Theuns & Juan Barnard	Eco-Char Namibia (Pty) Ltd: Directors	7 August 2014	Charcoal value chains
Lolo Goraseb	Office of the Prime Minister	7 August 2014	Value chains
Erich Petrus	Registrar of Agro-Chemicals and	7 August 2014	De-bushing, value chains

Name	Position	Date of interview	Topics covered
	Animal Feedstuffs, MAWF		
Ralph Gongol	Geva Renovations: owner	11 August 2014	Value chains (building materials)
Christo Viljoen	FNB Agri Division: Head	11 August 2014	Financial support measures, incentives
Dawid Botha	Odusa Trading: owner	11 August 2014	Bush control
Alex McDonald	NamAgri: owner	11 August 2014	Bush control
Norbert Liebich Olaf Liebich	Transworld Cargo: Director Projects	11 August 2014	Value chains, logistics
Dr. N. Nghifindaka	Namibia Emerging Commercial Farms' Union: CEO	14 August 2014	Extent of bush encroachment, de-bushing, policies
Oloff Munjanu	Namibia National Farmers' Union: CEO	14 August 2014	Extent of bush encroachment, de-bushing, policies
Eike Krafft	**O&L Energy:** Snr. Project Manager	14 August 2014	Value chains
Stefan Kondeilewski	Organic Energy Solutions: charcoal expert	14 August 2014	Charcoal
Dr. Detlof von Oertzen	VO Consulting	15 August 2014	Value chains
Rolf Wagner	**Farmer:** Moselle (Outjo)	18 August 2014	De-bushing, charcoal
Rudi Scheidt	**Farmer:** Erichsfelde (Okahandja)	20 August 2014	De-bushing
Lahja Amaambo John Langford	**NamPower:** Head: Renewable Energy Development, Strategic Planning Generation BU	3 September 2014	Energy generation value chains
Anneli Shishome Mr Amadhila	**Dir. Forestry:** Dep. Dir.: Forestry Mgt De-Bushing Coordinator	3 September 2014	Extent of bush encroachment, de-bushing, policies
Kamaauu Nandova	Agricultural Bank of Namibia: Manager: Midland branch	4 September 2014	Financial support for bush control
Georg Friedrich	**Farmer:** Gottesgabe (Gobabis)	9 September 2014	Value chains of encroacher bush
Johan Bruwer	Independent consultant	10 September 2014	Energy generation value chains

APPENDIX III: De-bushing questionnaire sent to producers

Dear Producer,

Please complete the questionnaire below and return to **agriconsult@iway.na** or fax to 061-256035 as soon as possible. Please use a separate questionnaire sheet for each farm. The questionnaire is also available in electronic version at **www.agrinamibia.com.na** and **www.namibian.com.na.**

Thank you for your co-operation!
Dr Axel Rothauge
GIZ De-Bushing Programme

FARM PARTICULARS	
Farm name	
Farm number	
District	
Farm size (ha)	

Please note the following concerning bush control methods:

1. Control method: with what and how? Please specify the method(s) used, e.g. chemical (name the chemical), aerial application (name the chemical used), chopping, etc.
2. If different methods of bush control were used, please specify each method in a separate column (bush control method number 1 to 5).

BUSH CONTROL PARTICULARS	**Bush control method 1**	**Bush control method 2**	**Bush control method 3**	**Bush control method 4**	**Bush control method 5**
Control method: with what and how?					
Area on which bush was controlled (ha)					
In what year(s) was bush controlled?					

BUSH CONTROL PARTICULARS	Bush control method 1	Bush control method 2	Bush control method 3	Bush control method 4	Bush control method 5
Was control method selective or unselective?					
Was the first control followed up with aftercare?					
In what year was aftercare applied?					
Aftercare: what method was used?					
Are you satisfied with this method of bush control?					
If you are not satisfied, please explain why					
Do you have *more* grass after this method of bush control?					
Do you have *better* grass after this method of bush control?					
Was the encroacher wood utilized in any way? How?					

INCENTIVE MEASURES
What incentives would motivate you to control more bush (in order of priority)?
Incentive 1:
Incentive 2:
Incentive 3:

APPENDIX IV: Comparison of bush control methods[67]

Chemical methods	Output, ha/day pp	Cost*, N$/ha	Selectivity of control	Ingre-dients	Timing	Advantages	Disadvantages	Comments
Aerial spraying	500-1,000	450-750 (air > 100)	completely unselective	foliar-absorbent arboricide	when in leaf (growing season)	i. covers huge areas ii. in shortest time	i. ecologically insensible ii. exceeds aftercare capacity iii. pollution potential iv. skeletons disintegrate slowly	i. arboricide concentration depends on soil clay content and woody species ii. hardly ever recommended
Manual application of pellets	5-10	250-500	selective	soil-absorbent arboricide	preferably not in winter	i. quickest manual method	i. poor control of labour ii. sideways pellet wash due to sheet erosion iii. poisons non-target plants because roots overlap	i. most common control method ii. epidimuron banned iii. bromacil enters groundwater iv. interrupt photosynthesis
Spray soil manually	3-10	200-400	very selective	soil-absorbent arboricide	all year	i. selective ii. dye improves labour control iii. much less erosion danger	i. slower but more precise than pellets (less root overlap) ii. careful when cleaning equipmt!	i. bromacil and tebuthiuron for "sekelbos" (e.g. Savanna) ii. triclopyr+picloram for broadleaf
Spray leaf manually	1-5	250-600	highly selective	foliar -abs. arboricide	when in leaf: grow. seaon	i. selective ii. does not kill grasses (like most soil-applied arboricides)	i. slow and tedious ii. wasteful spraying	most suited to open-up lines, fences, corridors, firebreaks, etc.
Manual methods	**Output, ha/day pp**	**Cost*, N$/ha**	**Selectivity of control**	**Ingredients**	**Timing**	**Advantages**	**Disadvantages**	**Comments**
Clear all bush	0.1	500-600	total eradication	labour-intensive	all year	selective; use wood; create temp. jobs; use canopy to re-seed grass	slow	only to make lands and clear strips
Excavate: thin only	0.2-0.5	100-150	highly selective	labour-intensive	all year	selective; use wood; create temp. jobs; use canopy to re-seed grass	slow	not for "sekelbos" – grows from root suckers
Fell + treat stumps	1-2	150-200	highly selective	labour-intensive	preferably not in winter	no (chemical) pollution danger	i. treat stump within 3 hrs of felling ii. more effective in summer	combines manual and chemical control
Stem burning	0.2-0.5	50-100	highly selective	labour-intensive	all year	"biological" method	i. danger of uncontrolled fire ii. consumes fire wood and dung	if you have lots of time and little money
Make charcoal	< 1	income > cost	highly selective	labour-intensive	all year	i. income far exceeds cost ii. excellent wood utilization	i. best charcoal made from thick stems (not invasive)	does not control invasive bush
Mechani-cal meth.	**Output, ha/day pp**	**Cost*, N$/ha**	**Selectivity of control**	**Ingredients**	**Timing**	**Advantages**	**Disadvantages**	**Comments**
Flatten, roll-over	8-15	300-500	fairly selective	Bulldozer	Aug-Oct	achieves 10-15% mortality (Omatjenne)	i. all mech. methods are expensive ii. most flattened bushes re-grow	not a method to control invasive bush
Bush cutter	1-5	400-700	very selective	Bush cutter	all year	selective	stems coppice if not treated chemically	more rapid than manual cutting
Excavate bush	1-3	500-800	selective	Tree puller	all year	selective	can penetrate dense thickets	more rapid than manual excavation
Chip bush	5-25	800-1,000	fairly unselective	Motorized chip-mill	all year	i. covers large area ii. 30% mortality at Omarassa	most chipped bushes coppice and re-grow	i. excellent wood utilization method ii. does not control invasive bush

67 : GESELLSCHAFT FŰR INTERNATIONALE ZUSAMMENARBEIT, 2012. Local Assessment Study to Support De-Bushing as Part of a Comprehensive and Sustainable Rangeland Management Strategy. Project report of 27 January 2012, GIZ, Windhoek, Namibia.

APPENDIX V: Charcoal statistics

a) Namibian charcoal processors:

Ian Galloway	Jumbo Charcoal	062-503838	0811281711	jumboch@iway.na
Hans Steyn	Carbo Namibia (FSC)	067-242386	0812791599	wildevy@iway.na
Maans Robberts	Etosha Charcoal	067-313797	0812381915	etoschar@iway.na
Patat du Toit	Superbraai	067-235016	0812887763	patat@mweb.com.na
Jannie Loots	Namibia Invaderbush Charcoal		0 811292174	info@iusnam.com
Kokkie Prinsloo	ENC & Blaze		0812922442	kenprinsloo@gmail.com
Gerhard Steyn	Kilo 40 (Ignite)	067-304789	0812338795	kilo40@mweb.com.na
Pieter Smeer	Oshakati Charcoal			pphoenix@mweb.com.na
Elke van Hacht	Makarra Bush Products	067-307209	0 813574056	mabupro@iway.na

b) NCPA membership:

Year	Paid-up members
2005	171
2006	178
2007	326
2008	335
2009	not recorded
2010	not recorded
2011	not recorded
2012	not recorded
2013	not recorded
2014	508

Baseline Assessment for the De-Bushing Programme in Namibia

This baseline study assesses the status of bush encroachment, sketches the institutional and political framework, the service organisations that provide farmers with advice and information, and ways to add value to wood from encroacher bush.

The author makes specific recommendations pertaining to the quantification of the encroacher bush resource to indicate the areas where different encroacher species predominate and their densities, and identifies various linkages for the Support to De-bushing Project to make specific interventions.

A critical recommendation is to streamline the exisiting policy frameworks and to compile comprehensible, user-friendly guides for farmers on rangeland management, including the management of bush encroachment.