Can the use of *Cannabis* (Hemp), when mixed with additives, be a suitable substitute to conventional building materials?

Philippa Anne Leitch

Can the use of *Cannabis (Hemp)*, when mixed with additives, be a suitable substitute to conventional building materials?

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In the faculty of Engineering, Built Environment and
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Study Leader
Prof JH Cruywagen

October 2009

Declaration by student

I, the undersigned, hereby confirm that the attached treatise is my own work and that any sources are adequately acknowledged in the text and listed in the bibliography.

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Signature of acceptance and confirmation by student

Abstract

Title of treatise:	Can the use of *Cannabis (Hemp)*, when mixed with additives, be a suitable substitute to conventional building materials?
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Institution:	Faculty of Engineering, Built Environment and Information Technology
Date:	October 2009

This research will determine if it is viable to cultivate and process hemp into a building material to be used in the construction industry of South Africa. The effect on the environment of manufacturing and using conventional materials will be compared the cultivation and production of hemp building materials. The general opinion of professionals and contractors will be determined regarding the use of hemp building materials in their design and also using such materials for construction. This research will establish if further training and education of using hemp building materials is necessary for skilled labour. Lastly, the current knowledge and research of hemp construction materials in South Africa will be verified, and which projects in South Africa are currently using such materials. The legalisation of cultivating this plant will be investigated.

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Chapter 1
Introduction

1.1 Overview of the topic

It has been known, for many years now that *Cannabis* (hemp) can be used as a building material when mixed with certain additives. Hemp is the common name for plants of the entire genus *Cannabis*, although the term is often used to refer only to *Cannabis* strains cultivated for industrial (non-drug) use.
(http://www.wikipedia.org Mar 2009)

1.1.1 The cultivation of hemp

The variety grown for industrial uses around the globe is *Cannabis sativia* L. subsp. s*ativia* var. *sativia,* whereas *C. sativia* subsp. *indica* is primarily used for the production of recreational and medicinal drugs. The difference between these strains is the appearance and the amount of tetrahydrocannabinol (THC) that is secreted in a resinous mixture by epidermal hairs called glandular trichomes. The strains of *Cannabis* approved for industrial hemp production produces an extremely small amount of THC, which is not enough to cause any physical or psychological effects. Industrial hemp contains below 0.3% THC, whereas *Cannabis* grown for the medicinal properties can contain up to 20% or more THC.
(http://www.wikipedia.org Mar 2009)

1.1.2 The environmental perspective

This plant is environmentally friendly. Farming industrial hemp indicates that it is meeting the objectives of a “Green Future” which is becoming increasingly popular. Hemp is easily grown, with little effort from farmers. (http://www.hemporium.com Jun 2009)

A benefit to farmers is that because of its height, dense foliage and high planting density as a crop, it is a very effective method of killing weeds, therefore no herbicides are required.
(http://www.hemporium.com Jun 2009)

The roots anchor and protect the soil from runoff, therefore building and preserving the topsoil and subsoil structures. The farming of hemp therefore controls soil erosion and another benefit is that it produces oxygen. (http://www.hempsa.co.za Feb 2009)

Hemp plants shed their leaves throughout the growing season; adding rich organic matter to the topsoil and helping it to retain moisture. Therefore, no irrigation is needed. Furthermore, no fertilizer or pesticides are needed for this plant to thrive.
(http://www.hempsa.co.za Feb 2009)

Hemp grows best in warm tropical zones or in moderately cool, temperate climates. Figure 1 indicates the climate zones that are well suited for the cultivation of hemp, and South Africa is among one of these areas. (http://www.wikipedia.org Mar 2009)

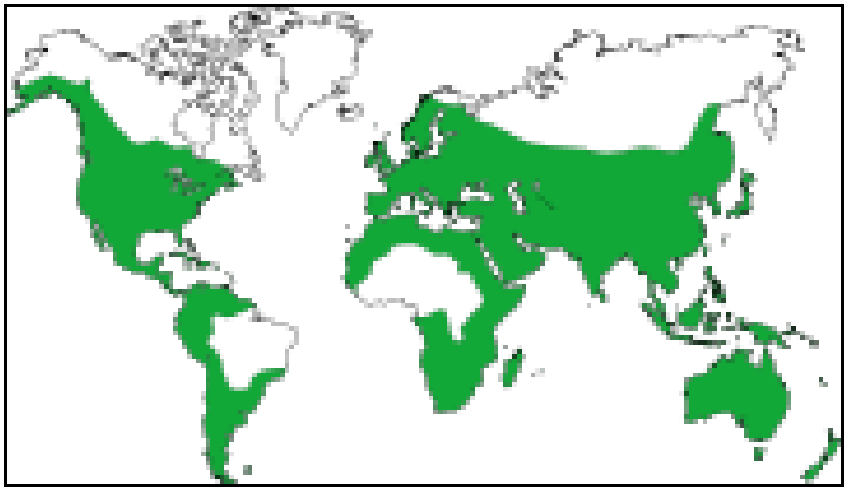


Figure 1: Climate zones well suited for cultivation of hemp
(http://www.wikipedia.org Mar 2009)

1.1.3 The harvesting of hemp

Hemp is extremely versatile. There are two main products which are processed from the plant, namely the male plant which is cultivated for stalks and seeds; and the female plant which produces large seed heads, and is cultivated for their seed, stalk and fibre. (http://www.hempbuilding.com Feb 2009)

Hemp that is grown for the fibre (also referred to as bast), is planted closely together resulting in tall slender plants, with long fibres. Hemp is an extremely fast growing crop, producing more fibre yield per acre than any other crop. The herb should be harvested before it flowers, as research shows that the fibre quality declines once the flowering process begins. (http://www.wikipedia.org Mar 2009)

1.1.4 The production of hemp

Industrial hemp, once cultivated, can be manufactured to produce an end product including paper, textiles, biodegradable plastics, construction materials, health foods and fuel. Industrial hemp is one of the fastest growing biomasses known, and one of the earliest domesticated plants known. For the purpose of this research, only construction materials will be researched.
(http://www.wikipedia.org Mar 2009)

The hemp stalk is similar to any other cellulose stalk, but this herb has greater strength and size properties compared to any other plant for the same weight and growing period.
(http://www.hempbuilding.com Feb 2009)

Hemp can be incorporated into the manufacturing of building materials straight from the field, because of its strength and engineering properties. Hemp fibre is one of the strongest and most durable of all natural textile fibres. Construction products made from

hemp will outlast any other product by many years. (http://www.hempbuilding.com Feb 2009)

Hemp is also known for its durability. The hemp fibre has a porous nature, and it is therefore more water absorbent and can dye well and retain its colour for longer. The porous nature allows the hemp to breathe, and that is one of the attributes to conserving energy with regards to energy saving costs in summer, as the building remains cool. Figure 2 shows the exterior of a house, which has been built using the masonry construction system. The thermo graphic image shows the heat retained in the walls of the house. The colour graduation represents the temperature scale of -3º C to 7.3º C. (http://www.hempbuilding.com Feb 2009)

Figure 2: Masonry house and thermo graphic image of masonry house. (Allin 2005:54)

Figure 3 shows the exterior of a house, which has been built with the hemp construction system. The thermo graphic image shows the heat retained in the walls of the house. The colour graduation represents the temperature scale of -3º C to 7.3º C. (http://www.hempbuilding.com Feb 2009)

Figure 3: Hemp house and thermo graphic image of hemp house. (Allin 2005:54)

Figure 3 shows the exterior of a house, which has been built with the hemp construction system. The thermo graphic image shows the heat retained in the walls of the house. The colour graduation represents the temperature scale of -3º C to 7.3º C. (http://www.hempbuilding.com Feb 2009)

The yellow circled areas of the hemp house are the foundations, where conventional clay bricks have been used in the construction. Houses that have been built using hemp as a building product conserve more energy than houses that have been built using conventional materials. (Allin 2005: 55)

The hemp bast and hurds, or the inner short fibre can be processed and used with existing construction products, and this can eliminate the need for adding strength and insulation to existing building materials. (http://www.hempbuilding.com Feb 2009)

1.1.5 Hemp in the construction industry of South Africa

There are many benefits of using hemp in the construction industry. Firstly, the size of the harvest: It's not called "*weed*" for nothing. Hemp grows quickly and easily; growing and harvesting hemp is labour intensive, so if it were to be grown on a large scale in South

Africa to be used in the production of building materials, it would create thousands of jobs for both the harvesting of the plant and the production of the building materials.
(http://www.hemporium.com Jun 2009)

Hemp, when used efficiently, results in a strong, lightweight and durable material, positively proving to meet the requirements of general building materials in South Africa. The hemp fibres that are added to concrete and other composite buildings materials increase the tensile compressive strengths and it reduces shrinkage and cracking. Such as hempcrete which contains hemp hurds.
(http://www.hempbuilding.com Feb 2009)

The fibres of this plant can be used in the manufacturing applications of different building materials (including hemp plaster, hempfibre insulation and hemp bricks and/or blocks). Building products containing hemp have been used in many different countries successfully for many years; and even in South Africa's neighbouring countries such as Lesotho and Swaziland. (http://www.construction-technologies.com/lyfordg/Hemp/hemp.html Feb 2009)

1.2 Statement of main problem

Can the use of *Cannabis* (hemp), when mixed with additives, be a suitable substitute to conventional building materials in South Africa?

1.3 Statement of the sub problems

1.3.1 Are the environmental aspects of cultivating hemp and the production of hemp building materials beneficial or detrimental to the environment?

- The greenhouse effect
- Carbon dioxide in the atmosphere

- The relationship between hemp and carbon
- The relationship between cement and carbon dioxide

1.3.2 Are professional consultants and contractors prepared to change their conventional way of thinking, to strive to reach a *Green Star Rating* and use hemp building products in their design or construction?

- Green building
- Green Star Rating
- Professionals and contractors

1.3.3 Would there be a need to further educate and train skilled labour on the use and application of hemp building materials, and will there be a need to introduce new tools for the application thereof?

- Hempcrete
- Hemp plaster
- Hemp blocks
- Finishes and details

1.3.4 What are the current knowledge, development and legalisation of hemp cultivation and hemp building products in South Africa?

- Research and knowledge
- Development and current projects
- Legalisation

1.4 Statement of hypothesis

1.4.1 The use of hemp as a building material is more environmentally friendly than conventional building materials. The cultivation of hemp will aid the environment to reduce the negative impact of global warming.

1.4.2 Professional consultants will be prepared to change their conventional way of thinking, and use hemp building products in their design to achieve a high Green Star Rating. Contractors will not be prepared to change their conventional construction methods.

1.4.3 There will be a need to further educate skilled labour on the use and application of hemp building materials, but the general application of hemp building products is similar to conventional construction methods therefore no training will be required. The tools used for the application of the hemp building materials will be very similar to the conventional tools used in today's construction.

1.4.4 The current research and knowledge is advanced in South Africa. There is little development and no current projects in South Africa. The legalization in South Africa states that the cultivation of hemp is still illegal, but there are permits available for research purposes.

1.5 Delimitations

This research is limited to South Africa. The cultivation, harvesting and production of hemp are limited to the Eastern and Western Cape where the plant is currently cultivated. The professionals and contractors to be consulted will be based in Pretoria, the suburbs of Hatfield and Silverton.

This research will be limited to products used for residential and industrial construction projects.

Aspects not covered in this research are the initial costs related to using hemp building products for construction; the cost of maintenance of building once completed and the economic life span of the building that is built using hemp building materials.

Researching of whether this product is currently approved by the South African Bureau of Standards (SABS) will not be done.

1.6 Definition of terms

- Hemp: refers to the herb, *Cannabis sativia* L. subsp. *sativia* var. *sativia,* which is cultivated for industrial use, and has no physical or psychological side effects.
- Bast: Fibrous part of the hemp herb.
- Hurd: Fibrous part of the hemp herb.

1.7 Abbreviations

- SABS: South African Bureau of Standards
- THC: Tetrahydrocannabinol
- etc: etcetera
- NAFI: National Agri-Fibres Initiative
- SLPSDI: Sir Lowry's Pass Sustainable Development Initiative
- SIVA: Sustainable and Integrated Villages for Agro-ecology
- KKOI: Klein Karoo Organic Initiative
- COBIFUBI: Community Bio-Fuels Beneficiation Initiative
- NOSSA: National Organic Seed of South Africa
- SAMPPI: Scented, Aromatic, Medicinal Plants Production Initiative
- SAVATE: South African Vehicles Advanced Technology Evolution
- COWIMBI: Community Waste Integrated Management Beneficiation Initiative
- CO_2: Carbon Dioxide
- AGW: Anthropogenic Global Warming
- º C: Degrees Celsius

1.8 Importance of the study

Although South Africa has a fairly stable economic system, the price increase of certain construction materials is ongoing. Besides the beneficial environmental quality hemp has, it also improves the living conditions of the people who utilise the building.

1.9 Research methodology

In determining whether the use of *Cannabis* (hemp), when mixed with additives, will be a suitable substitute to conventional building materials, the following research will take place:

Determining whether the use of hemp as a building material is more environmentally friendly than conventional building materials, articles will be consulted on the web. There is a book available called "Building with Hemp" by Steve Allin which will be used, and he will be contacted via email as he currently lives in Ireland.

A questionnaire aimed at determining whether: the professional consultants will be prepared to change their conventional way of thinking, and use hemp building products in their design; the contractors will be prepared to change their conventional way of thinking, and use hemp building products in their construction, will be composed and given to the relevant bodies in the construction industry. A minimum of fifteen professionals and contractors will answer this questionnaire to pose as a sufficient statistical population size.

To determine whether there will be a need to further educate and train skilled labour on the use and application of hemp building materials, Steve Allin will be consulted as he has years of experience

in the application of hempcrete, hemp plaster, hempfibre insulation etc.

In determining the research, knowledge, legislation and current projects in South Africa, the Professors of Elsenburg College in the Western Cape will be contacted and interviewed via email.

Chapter 2
Environmental aspects of using hemp in construction

Are the environmental aspects of cultivating hemp and the production of hemp building materials beneficial or detrimental to the environment?

2.1 Introduction

The process of manufacturing cement releases carbon dioxide (CO_2) into the atmosphere. CO_2 is a necessary gas in the atmosphere, but when the atmosphere is over polluted with this harmful gas, it is known that detrimental effects may occur. Cement, when produced and used, is only one of the building materials that is harmful to the atmosphere and is currently used in the construction industry of South Africa. An alternative product should be investigated. Can the use of Hemp as a building material be more environmentally friendly, in production and use, than other conventional building materials? (http://www.wikipedia.org Mar 2009)

2.2 The greenhouse effect

The earth receives energy from the sun in the form of radiation. Most of the energy received is in the form of visible wavelengths, and infrared wavelengths. The earth reflects approximately 30% of the incoming radiation. The remaining 70% is absorbed by the earth, which warms the land, atmosphere and the ocean. (http://www.wikipedia.org Mar 2009)

The absorbed solar radiation must be closely balanced with the energy radiated back into space. There is an exchange of energy between outer space, the earth's atmosphere, and the earth's surface. The ability of the atmosphere to capture and recycle the energy emitted by the earth surface is the defining characteristic of

the greenhouse effect. This will ensure the earth's temperature will remain at a steady state, not rapidly heating and cooling. Some of the infrared wavelengths emitted by the surface are absorbed in the atmosphere by green house gases and clouds, and therefore cannot escape directly into space. (http://www.wikipedia.org Mar 2009)

The greenhouse effect refers to the change in the steady temperature of a planet by the presence of an atmosphere containing gas that will absorb and emit infrared radiation from the sun. Greenhouse gases warm the atmosphere by efficiently absorbing thermal infrared radiation emitted by the earth's surface and by clouds. Examples of greenhouse gases are water vapour, carbon dioxide and methane. Because of the heat, the atmosphere will also radiate thermal infrared in all directions, including downward back to the earth's surface. (Figure 4) (http://www.wikipedia.org Mar 2009)

There are many chemical compounds found in the earth's atmosphere, which can act as green house gases. The gases allow the sunlight to enter the atmosphere freely. When the sunlight strikes the earth's surface, some of it is radiated back towards space as infrared radiation. The greenhouse gases absorb this infrared radiation and trap the heat in the atmosphere.
(http://www.eia.doe.gov Apr 2009)

The sources of greenhouse gas emissions come primarily from the combustion of fossil fuels. Fossil fuels are made up of hydrogen and carbon, and when burnt, it yields carbon dioxide. Methane is another greenhouse gas, which comes from landfills, coalmines, natural gas operations and agriculture. Nitrous oxide is emitted through the use of nitrogen fertilizers and from burning fossil fuels.
(http://www.eia.doe.gov Apr 2009)

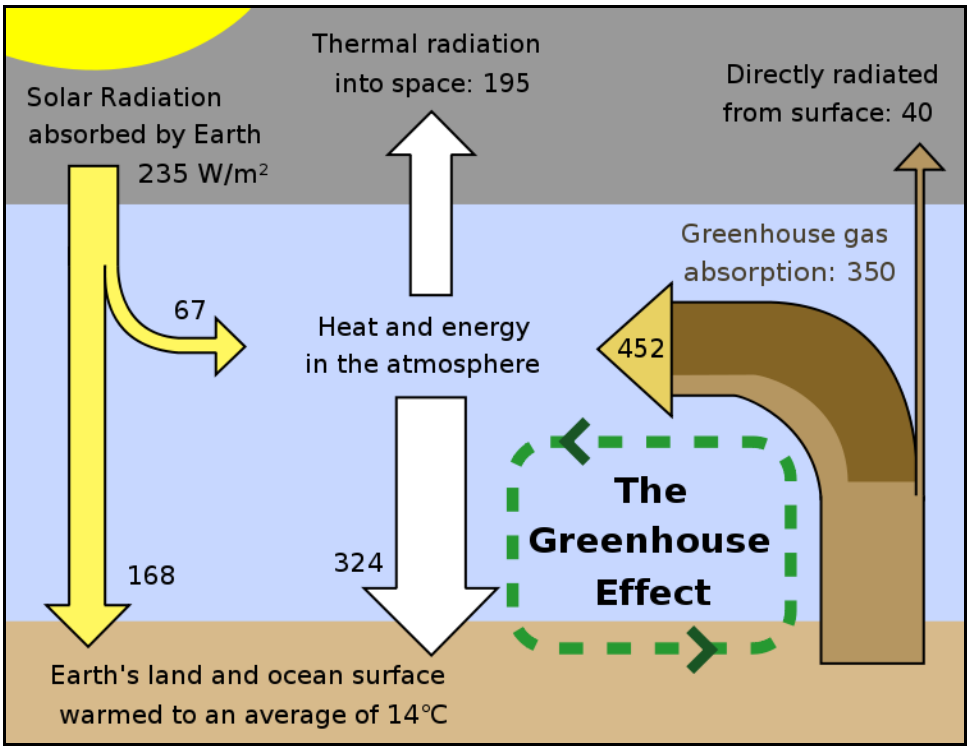


Figure 4: Schematic diagram of the exchanges of energy between outer space, the earth's atmosphere, and the earth's surface. (http://www.eia.doe.gov Apr 2009)

If there was no greenhouse effect in the atmosphere, the earth's average temperature of 14º C would be as low as -18º C which is referred to the as "the black body temperature of the earth." (http://www.wikipedia.org Mar 2009)

It is believed that the increase in concentrations of greenhouse gases in the atmosphere and changes of land use, mainly because of human interferences, has lead to the development of Anthropogenic Global Warming (AGW). AGW is the recent warming of the earth's lower atmosphere. (http://www.wikipedia.org Mar 2009)

2.3 Carbon dioxide in the atmosphere

The level of important greenhouse gases has increased by 25% in the last 150 years. In the last 20 years, 70% of these emissions are

because of burning of fossil fuels, therefore the emission of CO_2. The concentrations of carbon dioxide in the atmosphere are naturally regulated by numerous processes, known as the carbon cycle. (Figure 5) (http://www.eia.doe.gov Apr 2009)

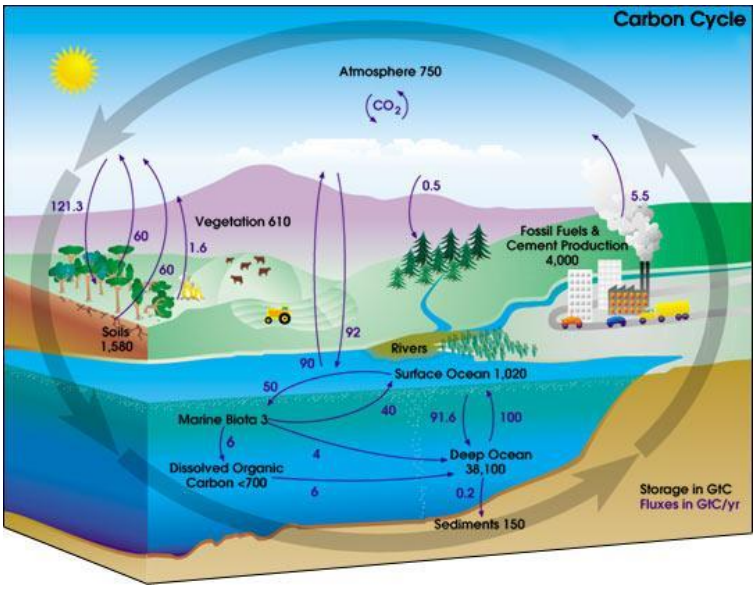


Figure 5: The Carbon Cycle. (Hobish April 2009)

Carbon dioxide is a critical component in the carbon cycle, being free in the atmosphere, dissolved in the oceans, integral in plant cells, and locked into sediments. (Hobish April 2009)

The movement of carbon between the atmosphere and the land and oceans is dominated by a natural process, such as plant photosynthesis. These natural processes can absorb some of the anthropogenic carbon dioxide emissions produced, but it cannot absorb all of the emissions. This positive imbalance between greenhouse gas emissions and absorption results in the continuing increases of the atmospheric concentration of green house gases. (http://www.eia.doe.gov Apr 2009)

The increase of greenhouse gases in the atmosphere increases the amount of infrared radiation that is trapped in the earth's atmosphere. This will ultimately increase the surface temperature of the earth over time. (http://www.eia.doe.gov Apr 2009)

2.4 The relationship between hemp and carbon

The hemp plant stores carbon, giving a "better than zero" carbon footprint. A carbon footprint measures the impact on the environment and is related to the amount of greenhouse gas produced. (http://www.news.bbc.co.uk Apr 2009)

The hemp in certain building materials helps to reverse the damaging effects of greenhouse gases. For example, hempcrete locks up approximately 110 kg of CO_2 per m^3 of wall and provides one of the best value materials for low impact, sustainable and commercially viable construction. (http://www.overmassandchapple.com Apr 2009)

It is believed that the construction industry is a major contributor of environmental pollutants. Many institutes are researching low carbon alternatives to building materials that are currently used in the construction industry. In 2008, Professor Peter Walker quoted "It is estimated that worldwide the manufacture of cement contributes up to 10% of all industrial carbon dioxide emissions. We are looking at a variety of low carbon building materials including crop-based materials, innovative uses of traditional materials and developing low carbon cements and concretes to reduce impact of new infrastructure. As well as reducing the environmental footprint, many low carbon building materials offer other benefits, including healthier living through higher levels of thermal insulation and regulation of humidity levels." (http://www.news.bbc.co.uk Apr 2009)

2.4.1 The growing of hemp

Hemp is currently grown on large scale in Canada, China, Russia and Australia. In an environmental perspective, the plant's greatest feature is that it breathes in more carbon dioxide than any other plant and that it grows at an amazingly rapid speed. It turns the carbon dioxide in the atmosphere into incredibly rich wood and strong fibres. It therefore benefits not only the quality of the plant, but also helps reduce the quantity of carbon dioxide in the atmosphere. (http://www.natural-environment.com Apr 2009)

Benefits of Hemp as a crop:

Hemp produces the same amount of oxygen while it is growing that it would use in carbon dioxide if burned as a fuel. Also, due to the leaf/root ratio (this can often be 10% roots vs. 30% leaves); hemp can produce between 20% - 40% more oxygen than will be polluted. (http://www.natural-environment.com Apr 2009)

"Material is actually carbon negative; it means that en masse use removes CO_2 from the atmosphere. Hemp will absorb ten tones of CO_2 per hectare per annum." (McCabe 2005)

Hemp can actually clean up toxins from the ground. This process is called phytoremediation. (A good example of this process is when hemp was used to help clean up the Chernobyl nuclear disaster site to remove radioactive elements from the ground.) (http://www.natural-environment.com Apr 2009)

Benefits of Hemp as a product:

Naturally, products made from hemp are 100% biodegradable, recyclable, and reusable. In addition, the speed at which hemp grows can provide benefits regarding the resource requirements of the end product. (http://www.natural-environment.com Apr 2009)

2.5 The relationship between cement and carbon dioxide

Cement is a dry powder substance, which is used as a binder, a substance that will set and harden independently. It can also be used to bind other materials together. The most common use for cement is the production of mortar and concrete: The bonding of natural and artificial aggregates to produce a strong building material that is durable. (http://www.wikipedia.org Mar 2009)

In 2008 Dimitri Papalexopoulos said, “No matter what you do, cement production will always release carbon dioxide. You can't change the chemistry, so we can't achieve spectacular cuts in emissions.”

The manufacturing of cement contributes to greenhouse gases both directly and indirectly. Directly in production: calcium carbonate is heated, producing lime and carbon dioxide. Indirectly: Using energy, especially when the energy is sourced through the burning of fossil fuels. The cement industry produces 5% of all the man made CO_2 emissions. 50% of this is generated from the chemical process and 40% is from burning fuel. For every 1000 kg of cement produced, 900 kg of CO_2 is emitted into the atmosphere. (http://www.guardian.co.uk/environment/2008/dec/31/cement-carbon-emissions May 2009)

2.6 Summary

The construction industry of South Africa and the use of buildings accounts for over 50% of the carbon dioxide produced. Studies have shown that the emission of CO_2 can be up to 200 kg in the production of each square meter of walling for houses alone, equating to 40 tons for the walls of a typical house. With the use of hemp building products, carbon dioxide emissions will drastically reduce. (http://www.overmassandchapple.com Apr 2009)

2.7 Conclusion

Taking our environmental responsibilities seriously, the construction industry of South Africa should start to use hemp building products as a preferred building material. Hemp building products can actually reverse the damaging effects of greenhouse gases by locking up harmful CO_2 emissions. By using hemp building products, this will promote the farming of hemp, which is extremely beneficial to the atmosphere and the land.

"To help save ourselves from the ravages of global warming, we must grow massive quantities of hemp all over the world to clean the air and provide bio fuel" (Davis 2002)

2.8 Testing of the hypothesis

As stated in the introductory chapter, the hypothesis answer is the following:

- The use of hemp as a building material is more environmentally friendly than conventional building materials. The cultivation of hemp will aid the environment to reduce the negative impact of global warming.

- The hypothesis stated is true and accepted. The environment of not only South Africa, but worldwide, will be positively impacted if hemp is grown on a large scale. If hemp building products are manufactured, the emission of carbon dioxide into the atmosphere will be drastically reduced.

Chapter 3
Awareness in South Africa

Are professional consultants and contractors prepared to change their conventional way of thinking, to strive to reach a Green Star Rating and use hemp building products in their design/construction?

3.1 Introduction

Green building is the science of creating a structure that is energy efficient, resource efficient and environmentally responsible. It is the art of building design that minimizes negative impact on the environment by incorporating efficient application of resources through effective utilization of wind, water, and sunlight. (www.masterbuilders.co.za Aug 2009)

On a practical level, this encompasses the use of design, materials and technology to reduce energy and resource consumption and create improved human and natural environments. Specific green building measures include careful building design to reduce heat loads, maximise natural light and promote the circulation of fresh air; the use of energy-efficient air-conditioning and lighting; the use of environmentally friendly, non-toxic materials; the reduction of waste, and the use of recycled materials; water-efficient plumbing fittings and water harvesting; the use of renewable energy sources; and sensitivity with regard to the impact of the development on the environment. (http://www.gbcsa.org.za Aug 2009)

Another vastly significant characteristic of Building Green is the inclusion of measures that reduce energy output. Factors that are incorporated include high-efficiency windows as well as insulation in walls, ceilings, and floors. (www.masterbuilders.co.za Aug 2009)

“Energy efficiency is fast becoming one of the defining issues of our times. Buildings use more energy than any other sector and as such are a major contributor to climate change. Unless there is immediate action, thousands of new buildings will be built without any concern for energy efficiency, and millions of existing, inefficient buildings using more energy than necessary will still be standing in 2050. Acting now means reducing their energy consumption and making real progress in controlling climate change. The market alone will not be able to make the necessary changes. Most building owners and occupants don’t know enough and don’t care enough about energy consumption, and inertia is reinforced by assumptions that costs are too high and savings too low. That’s why we are calling for a major, coordinated and global effort. If we can create that, we will cut greenhouse gas emissions and stimulate economic growth at the same time.” (Stigson, 2009)

3.2 The Green Star Rating

There are several rating systems in existence worldwide, including LEED from the US, BREEAM from the UK and Green Star from Australia. After a process of industry and expert consultation, the Green Building Council of South Africa Board decided to base our South African rating tool on the Australian Green Star system, and to customise this tool for South African use.
(http://www.gbcsa.org.za Aug 2009)

The Green Building Council of South Africa develops the Green Star SA rating tools, based on the Australian Green Building Council tools, to provide the property industry with an objective measurement for green buildings and to recognise and reward environmental leadership in the property industry. Each Green Star SA rating tool reflects a different market sector: office, retail, multi-unit residential, etc. (http://www.gbcsa.org.za Aug 2009)

A green building ratio tool set standards and benchmarks for green building, and enables an objective assessment to be made as to how “green” a building is. The rating system sets out a “menu” of all the green measures that can be incorporated into a building to make it green. Points are awarded to a building according to which measures have been incorporated, and, after appropriate weighting, a total score is arrived, at which determines the rating. (http://www.gbcsa.org.za Aug 2009)

To achieve certification, building owners submit documentation to the Green Building Council of South Africa who employs independent assessors to assess the submission and score the building. Certification is awarded for 4-Star, 5-Star or 6-Star Green Star SA ratings. (http://www.gbcsa.org.za Aug 2009)

Green Star SA tools are developed through a consensus based process led by a volunteer technical working group. A technical working group is formed for each separate rating tool and consists of technical experts and industry practitioners from a cross-section of the relevant market sector. (http://www.gbcsa.org.za Aug 2009)

Most rating tools offer two different certifications: “Design” and “As Built”. A “Design” certification can be submitted for and awarded at the end of the design phase of the project. The intent is that the building can then be marketed as a Green Star SA certified building, having demonstrated the green building strategies to be included in the building. At the end of construction, a project can submit for and be awarded “As Built” certification, certifying that all green building strategies were in fact incorporated into the final building. The two types of certification are completely separate, and a Design certification is not a prerequisite for an As Built certification. (http://www.gbcsa.org.za Aug 2009)

Design submissions can be submitted as soon as the required evidence is available; this could be prior to commencement of construction. The Certified Rating can be achieved prior to practical completion, but must be achieved no later than 24 months after practical completion. As Built submissions must be submitted after practical completion, and the Certified Rating must be achieved no later than 24 months after practical completion.
(http://www.gbcsa.org.za Aug 2009)

Product suppliers are welcome to market their product as contributing to a project's Green Star SA rating. However, a product cannot be Green Star SA certified, Green Star SA rated, or in any other way officially approved by Green Star SA. The Green Building Council of South Africa does not endorse any claims. Suppliers will need to validate the environmental merit of a product or material in a project's submission for Green Star SA assessment.
(http://www.gbcsa.org.za Aug 2009)

3.3 Awareness in South Africa

Although this rating tool has already been implemented in South Africa, many still seem to be stuck in their conventional way of thinking. We still see designs and building techniques using conventional methods and materials, which is adding to the global construction crises of polluting the atmosphere, which results in an increase of green house gases being released.

A questionnaire to determine what the current thoughts of the professional consultants and contractors are, regarding green building and the use of hemp building materials, was composed and sent to the following: Architects, quantity surveyors, engineers and building contractors.

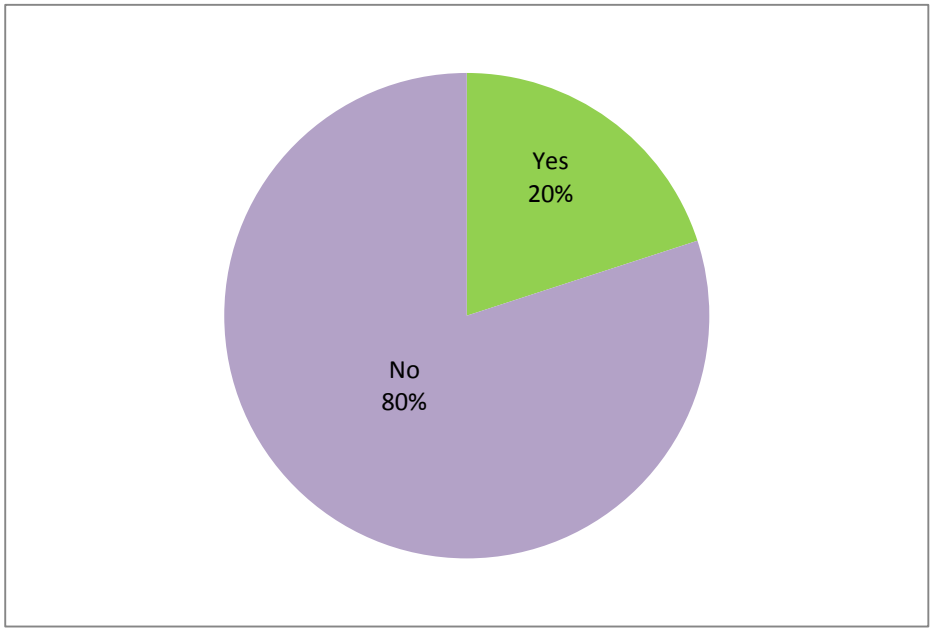


Figure 6: Awareness that hemp can be cultivated for use in building materials. (Own information 2009)

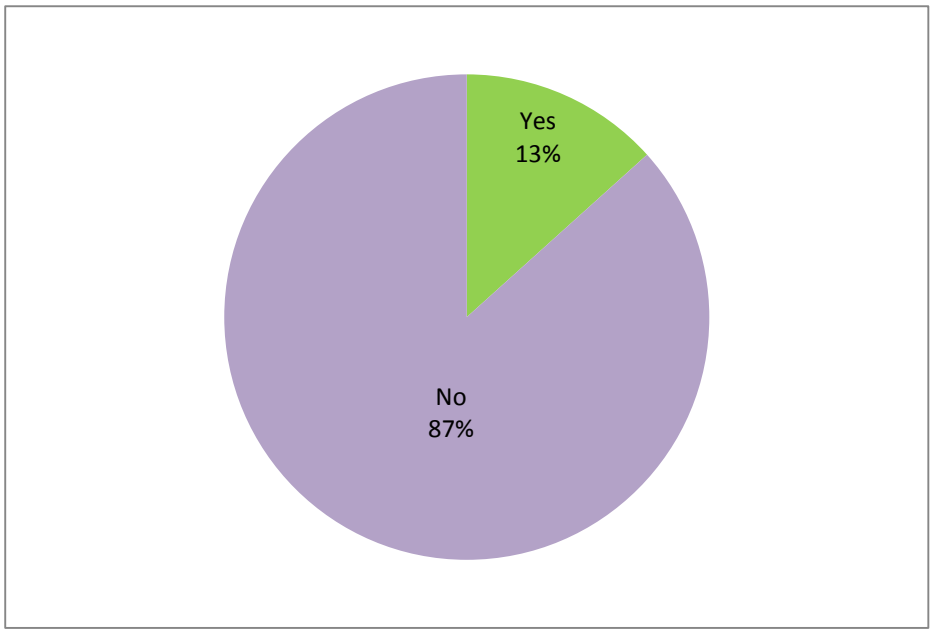


Figure 7: Awareness that building materials containing hemp are available in South Africa. (Own information 2009)

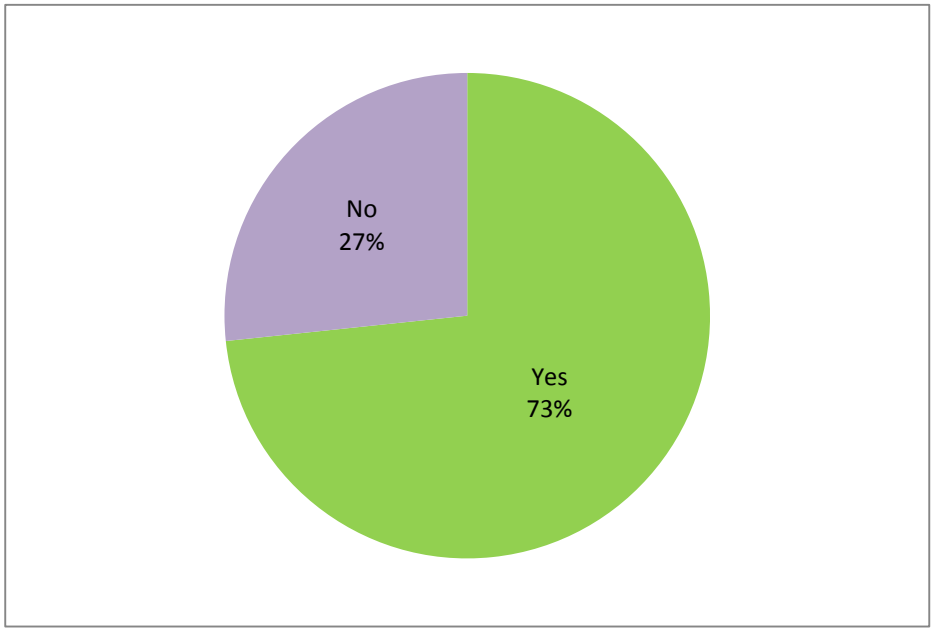


Figure 8: It is of importance for the construction projects in South Africa to focus on more eco-friendly and or green building materials? (Own information 2009)

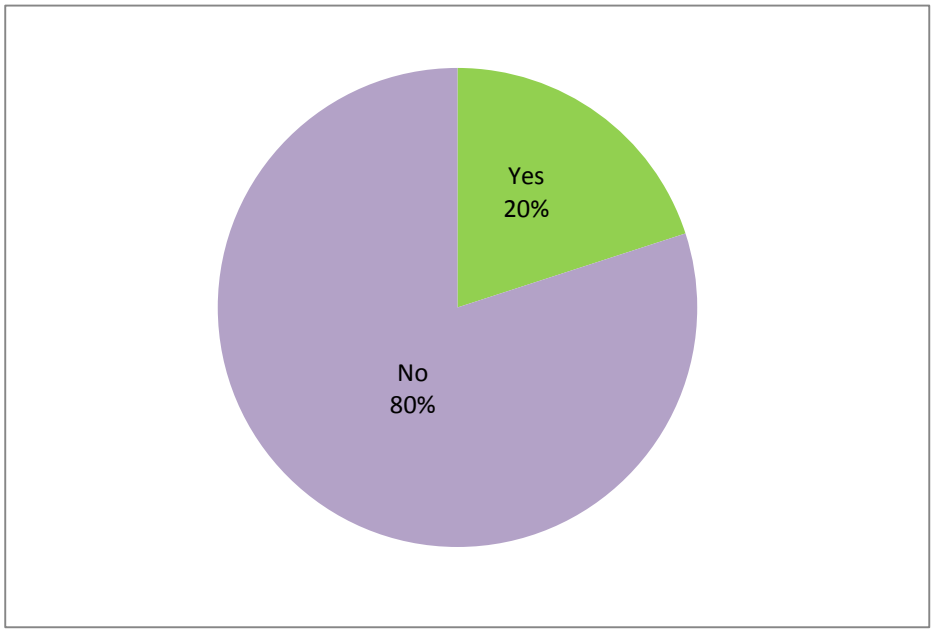


Figure 9: Awareness of any current projects in South Africa which are using building materials containing hemp. (Own information 2009)

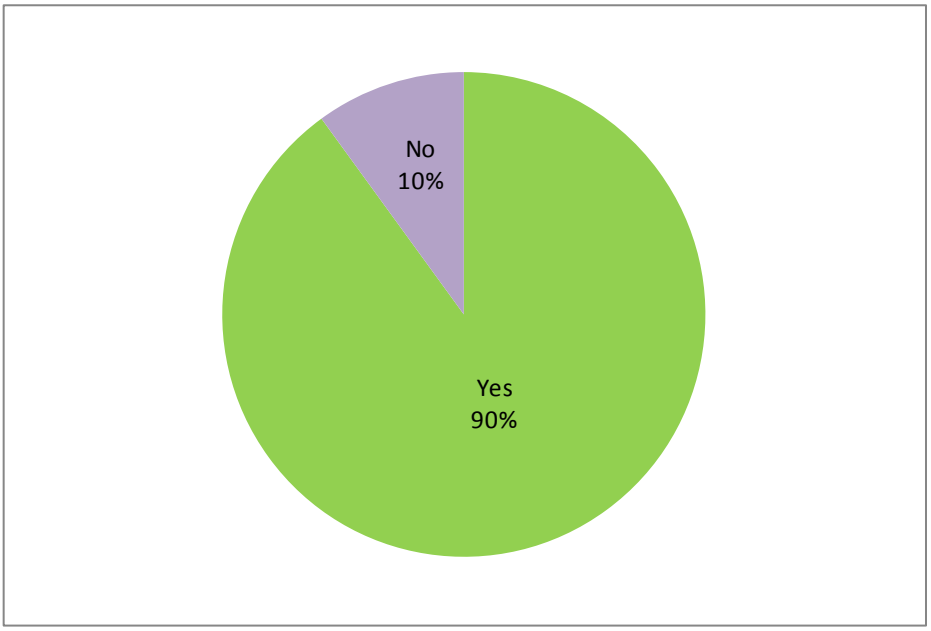


Figure 10: Will the design team be prepared to design a project that will contain hemp building materials? (Own information 2009)

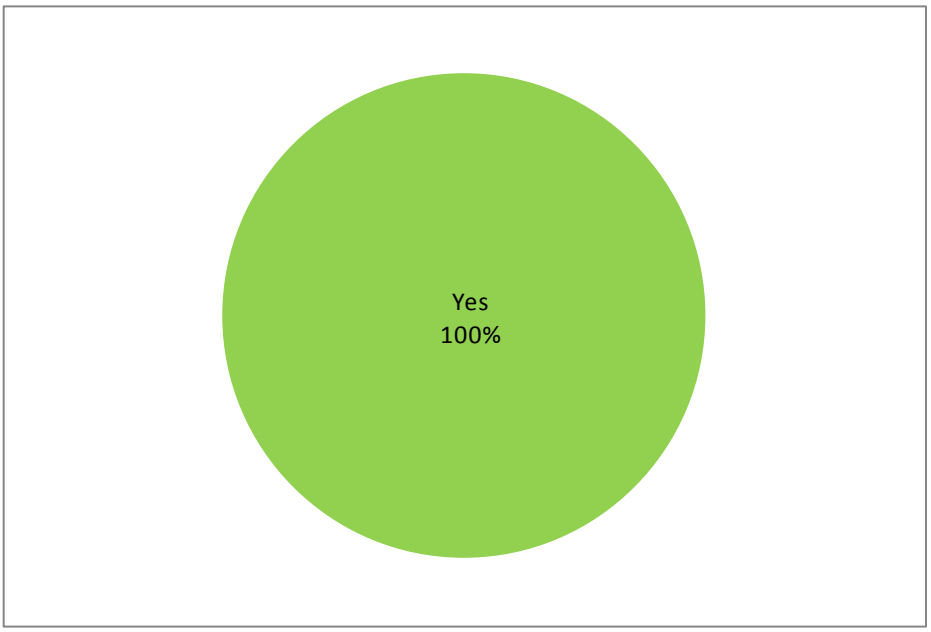


Figure 11: Will quantity surveyors be prepared to cost a project and control the budget of a project where the building materials specified contain hemp? (Own information 2009)

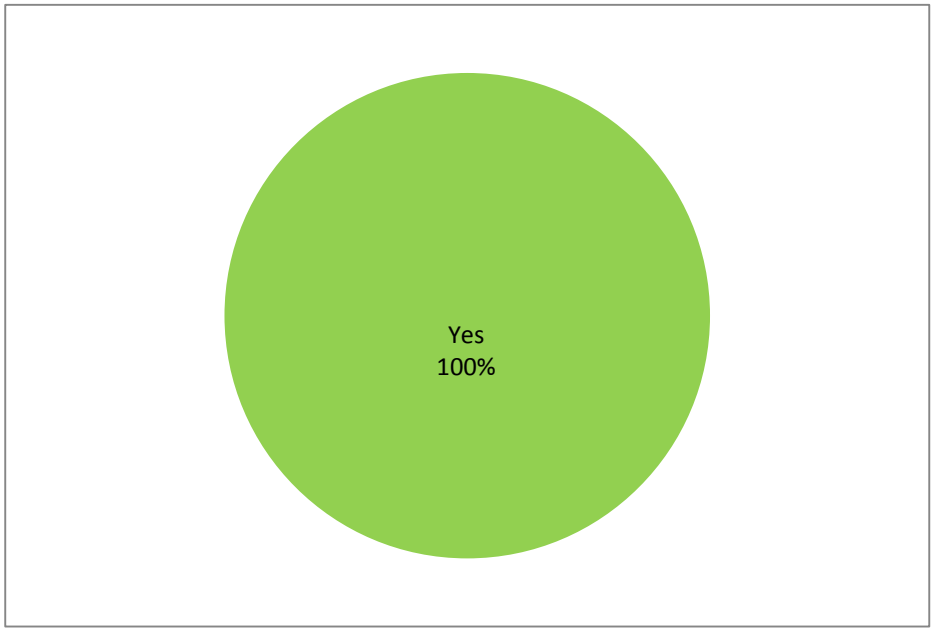


Figure 12: Will contractors be prepared to construct a project if the materials specified for construction are to contain hemp? (Own information 2009)

3.4 Interpretation and discussion of the results:

It is evident that very few professionals and building contractors are aware of the use of hemp in construction. This indicates that there is little knowledge about hemp building products available to the professionals. Building products containing hemp may still be a fairly new concept in South Africa.

It is widely agreed that green building and environmentally friendly construction techniques and material are extremely important in South Africa.

Very few professionals and contractors are aware of any current projects under way in South Africa that is using hemp building materials. This may be a result due to the lack of knowledge of this plant.

Both the architects and engineers feel comfortable using building products containing hemp in their design. The general condition would be proven tests of its application, strength and durability.

The quantity surveyors are comfortable to control the costs of a project, which has specified the use of hemp building materials.

The building contractors are fairly comfortable to construct a building using the different available hemp products. Many contractors stipulate that they would only use products which are SABS approved.

3.5 Summary

Hemp building products still have a long way to go in the South African building industry. However, once tried and tested, many professionals and building contractors will be prepared to change their conventional way of thinking and use building materials in their design and construction.

3.6 Conclusion

The introduction of the Green Star Rating Tool in South Africa will benefit the environment and help to reduce waste and pollution on construction sites. By combining the rating tool and environmentally friendly building products such as materials containing hemp, could lead to a more “green” South Africa.

3.7 Testing of hypothesis

As stated in the introductory chapter, the hypothesis answer is the following:

- Professional consultants will be prepared to change their conventional way of thinking, and use hemp building products in their design to achieve a high Green Star Rating. Contractors will not be prepared to change their conventional construction methods.

- The hypothesis stated is partially true and accepted. The professionals and the building contractors are both encouraged by the introduction of hemp building materials and products. The design team will definitely introduce hemp products into their design, and once approved by the SABS, the building contractors will use the products in their construction.

Chapter 4
Education and Training

Would there be a need to further educate and train skilled labour on the use and application of hemp building materials, and will there be a need to introduce new tools for the application?

4.1 Introduction

Hemp building products have been used for many years in foreign countries. In South Africa, where we construct projects with labour intensive methods, it will be advantageous if the building materials containing hemp are suited to labour intensive methods.

4.2 Hempcrete

There have been many trials, tests and experimenting done with the hempcrete material. There are four main different mixtures of hempcrete available that have been evolved to be used in construction. (Allin 2005: 44)

By combining the hemp hurds with varying amounts of lime, the elements of insulation and structure can be adjusted to suit the different uses. (Allin 2005: 44)

- Lightweight hempcrete

This is used for its insulation qualities primarily, and structure is of least importance. This hempcrete will be applied to areas where material is only required to stay in place, such as loft spaces and between floors. This mixture has only sufficient lime added to the hurd to approximately 10% of the volume in order to coat the hemp particles and fix them to each other, so that the whole becomes and weak mass. (Allin 2005: 44)

- Wall hempcrete

In order to withstand the forces of impact, wind loading and the additional structure rigidity likely to be needed by the wall, the amount of lime added to the hempcrete mix is increased to around 25% of the volume in order to more solidly bind the hemp particle together in more ridged manner, but to retain as much of the insulation qualities as possible. (Allin 2005: 44)

This and the aforementioned lightweight hempcrete may contain up to 10% of the volume of hurd as fibres to add to an element of reinforcement to the structure. (Allin 2005: 44)

- Floor hempcrete

When used as an insulating material beneath a solid floor at ground level when slightly more compressive strength is needed for the hempcrete to withstand the loading between the gravel beneath and the mortar and tiles above. Also, when there is a screed to provide thermal mass for under floor heating systems. For this application the lime portion of the mix is increased to 50% of the volume.
(Allin 2005: 44)

To mix hempcrete for casting in any of the positions it might be used; a particular blend of limes and binders needs to be formulated to then be mixed with the hemp. (Allin 2005: 146)

The exact mixture of materials will depend to a certain extent on the climate where they are to be used and the method of application.
(Allin 2005:146)

In dry warm climates and If the hempcrete is to be applied by hand between shuttering boards, then fast acting binders such as cement

or fast acting hydraulic limes should be avoided as large amounts of hempcrete will not be able to be mixed in advance. (Allin 2005:146)

In damp, cool climates the quantity of water should be reduced so as to speed up the drying time. (Allin 2005:146)

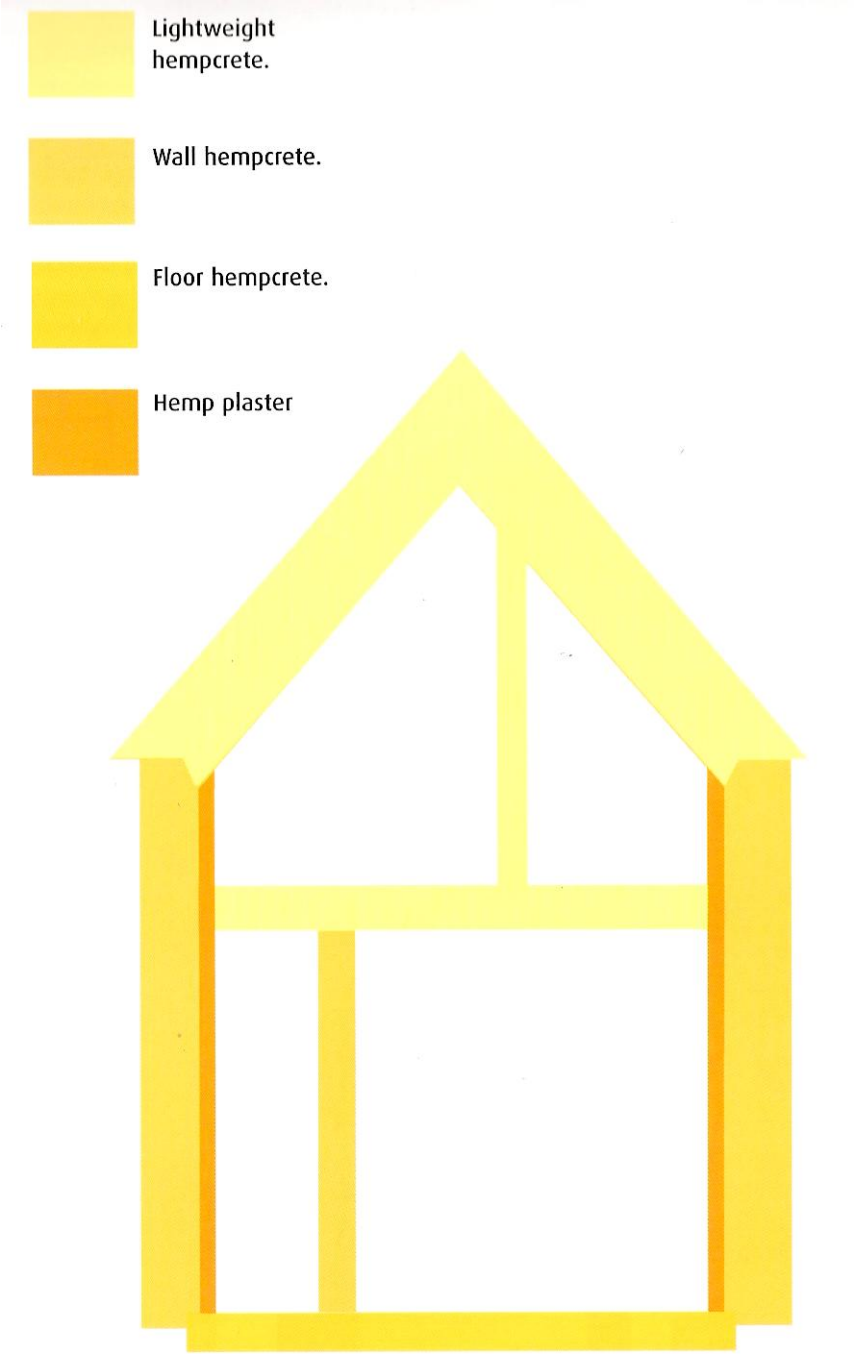


Figure 13: Illustration of where the different mixes are used.
(Allin 2005: 25)

When using the concrete pump to spray hempcrete, Portland cements or extremely hydraulic limes should be incorporated into the mix as the hempcrete needs to start to set immediately so that it can keep its position and that the shuttering can be removed very soon after the material has been applied. (Allin 2005:146)

When a hempcrete wall is to be left exposed without a covering of plaster or board, it is more pleasant to be looking at a lighter creamy colour rather than the grey that is produced by Portland cement; in this case white cement can be used. (Allin 2005:146)

In situations where the thermal capacity is to be increased, such as an internal wall, the quantity of sand should be limited to 20% of the volume of the mixture. (Allin 2005:146)

- Spraying hempcrete

In recent years a method of applying hempcrete by spraying against formwork has been developed by a company in Brittany named C.T.C. This reduces the time taken for this element of the job considerably. (Allin 2005:156)

During the operation of this combination of machinery the hemp and lime are placed in the hopper which then is lifted hydraulically and tipped into the adapted mixer which, in a matter of 3 minutes or so, has completed the combination of the materials and then steadily empties the dry mix into the hopper on the top of the pump. By means of rotating chambers, the dry hempcrete is then blown along the pipe with considerable force. (Allin 2005:156)

Water quantities are controlled by the operator by means of valves at the end of the pipe. (Allin 2005:156)

This method has several advantages over the manual method other than speed, in that the mixture requires less lime and water in the mix which increases the insulation value and lessens the drying time. (Allin 2005:156)

Other differences to this system compared to normal shuttering with hempcrete, are that due to the direction of the force, the hempcrete is being propelled into the framework and against the shuttering boards. These boards can be of lighter dimensions. With the tamping method, the material is pressed downwards, which bonds the layers of material together. However it can, if overdone, force the shuttering boards either side apart causing a bulge in the wall. (Allin 2005:157)

With the spray method this doesn't happen, although the impact of the air driven material is such that it is necessary to drape a sheet of polythene inside the shutter board to prevent the hempcrete adhering to too great an extent. This is then peeled off the surface of the hempcrete when the shuttering is removed. (Allin 2005:157)

Once the hempcrete has built up to the required thickness against the external or internal boards (depending on which way round the job is being done) the surface of the hemp is then raked flat and levelled off with a straight edge. (Allin 2005:157)

Before this work of spraying is carried out, all woodwork, doors or window and surrounds together with lintels or rafters whether painted or not, should be masked with polythene or tape. As to clean the hemp and lime off afterwards is very laborious. (Allin 2005:158)

A first coat of lime and sand plaster can be sprayed onto a hempcrete surface immediately after it has been applied. Hempcrete

applied internally during renovation, or a complete wall of the material, is best protected by such a coat of plaster as it helps the hempcrete to dry out. (Allin 2005:158)

The most efficient way of doing this is to spray it on using a compressed air gun made for such a purpose. As it is not essential to completely seal the surface of the hempcrete, the plaster can be sprayed quite quickly. The mix can be quite dry so as to give a rough surface to provide a key for the next coat. (Allin 2005:158)

Later when the wall has dried out the final coats of lime plaster both external and internal can be applied. It is better to wait till this point, as during the drying process tannins might leach out and discolour the plaster. (Allin, 2005:158)

4.3 Hemp plaster

In order for the mix of hemp and lime to meet the requirements of a plaster, sufficient lime needs to be added to produce a workable material, and to bind the hemp hurds together to form a practical surface. To do this, the lime content is increased to 85 – 90%. In some situations it is advisable to incorporate ground limestone into the mixture in order to increase the water retention abilities of the plaster in situations where it might dry out too quickly. Sand might also be added to produce a harder wearing surface or to enable it to be applied with a spray gun. (Allin 2005:158)

A smooth surface can also be obtained by using the sieved smaller particles of hurd to mix with the lime. These smaller particles produce a more plastic material which can be more easily smoothed with a trowel of float. (Allin, 2005:159)

- Hemp plaster

To mix hemp with a lime based binder in order to use it as a plaster it is preferable, if applying the substance by hand, to use a hemp chip that has been sieved so that only the smaller particles (i.e. 1-5 mm in length) remain. (Allin 2005: 147)

If using a spray gun to apply the hemp plaster, then the normal particle size (5-30mm) can be used if a particularly smooth surface is not required. (Allin 2005: 147)

The plaster mix has a higher quantity of hydrated lime in it, in order to give a more plastic consistency to the material so that it can be spread out on the wall more easily. (Allin 2005: 147)

When using hemp plaster in hot dry climates, ground limestone can be added to the mixture to retain moisture for longer.
(Allin 2005: 147)

When applying hemp plaster to a hard background, such as concrete or dressed stone, the wall should be sprayed or rough plastered with a coat of lime render containing a hydraulic lime with a high compression strength first. This is so that the hemp plaster adheres properly to the background. (Allin 2005: 147)

To make the plaster harder and more able to take knocks the addition of sand is recommended. (Allin 2005: 147)

The application of hemp plaster with a spray gun is only possible with the addition of sand. This is to give the material sufficient weight to enable the plaster to fall down in the hopper and into the chamber to be propelled by the compressed air. (Allin 2005: 147)

- Spraying hemp plaster

Protective clothing and equipment must be worn when using a spray gun. There is especially a risk of lime entering the eyes and this is not recommended. (Allin 2005: 159)

A plaster spray gun can be used to apply hemp plaster in the same way as it is used to apply a conventional plaster of lime and sand. (Allin 2005:159)

The gun itself consists of a hopper and chamber with nozzles for the compressed air to enter the mixture. It comes supplied with a number of plates with varying sizes of holes for the plaster to leave the gun. When used for hemp we require the plates with the largest of these to allow the particles of hemp to be blown out.
(Allin 2005:159)

The mix is also altered by the addition of sand. This lowers the insulation value slightly but is necessary to provided weight to the material so that it falls down inside the hopper as it is being blown out. (Allin 2005:159)

The addition of sand also produces a grittier surface, though it is harder and flatter. It is worked with a wooden or plastic float to the required finish. (Allin 2005:159)

- Hemp plaster by hand

The most important aspect of plastering with a hemp plaster is the consistency. This does not depend on a one-mix does all approach, it will depend on what finish is desired, the type of background to be plastered and the atmospheric conditions. (Allin 2005:160)

Although the constituents of the mixture should be well combined, it is not advisable to leave the plaster mixing too long in the machine even though it might seem as if it is a creamier consistency. Too much air in the mix will cause the plaster to set as a frail sponge-like structure and not be strong enough. (Allin 2005:160)

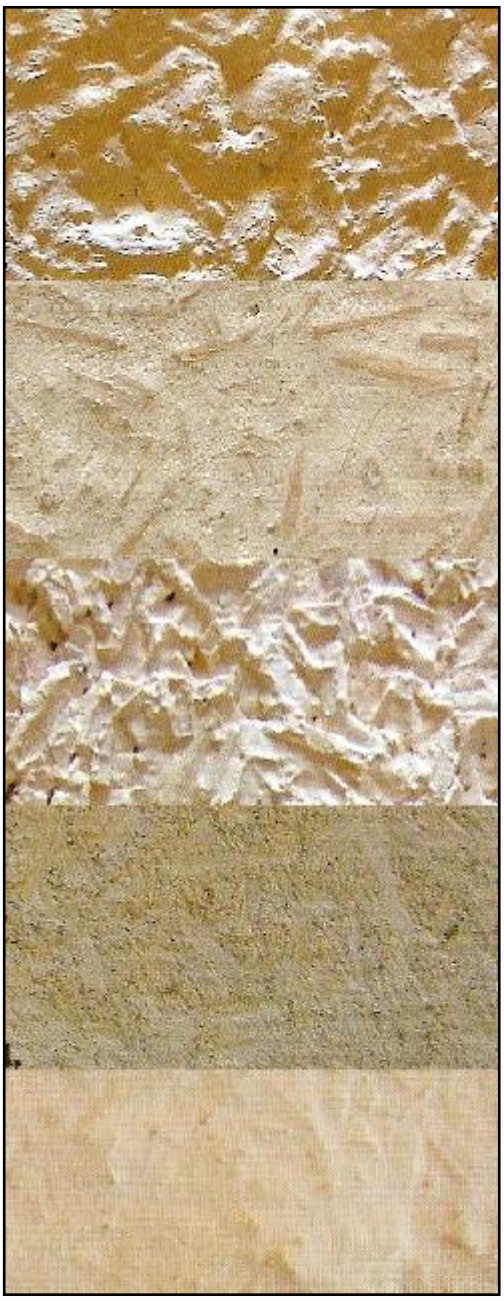
The surfaces to be plastered must be assessed for the quantity of water they will soak up whilst plastering, as hemp plaster will not adhere to too dry a surface. (Allin 2005: 160)

If the wall is of moderate absorbency then larger areas can be sprayed with water and plastered in linger sessions. (Allin 2005:160)

The method used to put the plaster on the wall will be a personal preference. Professional plasterers are used to a very malleable material they can move around their hawks and apply with a float like butter; hemp plaster is not like this. (Allin 2005: 160)

The finer grades of hemp, separated by the processor for plastering are much easier to use and a finer finish is more easily achieved. Figure 7 shows the different finishes available when using hemp plaster. (Allin 2005:160)

When mixed with sufficient lime to become a plaster almost all the spaces between the hurds are filled with the lime mixture, therefore producing a more solid material that nonetheless still breathes and insulates. Provided it is applied to a wall constructed of a material such as brick, stone, or indeed Hempcrete it will work perfectly. (Allin 2005: 45)



Rough hemp plaster painted with thick lime wash.

Rubbed finish.

Rough unfinished.

Sprayed hemp plaster finished with wood float.

Smooth hemp plaster lime washed.

Figure 14: Hemp plaster finishes. (Allin 2005: 67)

4.4 Hemp blocks

- Pre-casting

Whenever the concept of making bricks from clay or mud was first tried, we cannot be sure, but structures such as the arches of ancient culverts made from this material have been found dating back 7000 years or more. (Allin 2005: 74)

For various reasons it has been found to be more convenient to make bricks than to mould the wall in one piece. (Figure 8 & 9) With a material such as hempcrete there will situations where a hemp-lime block will be a more suitable way to build, than to cast an entire wall in one go. (Allin 2005: 74)

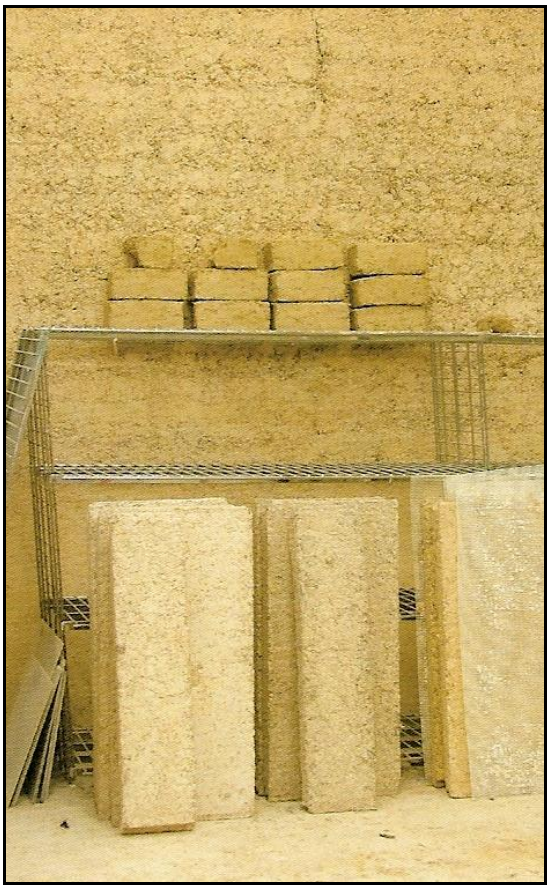


Figure 15: Precast hemp bricks and blocks made from a mould. (Allin 2005: 82)

Figure 16: Precast hemp brick made from a mould. (Allin 2005: 82)

The advantages of a hempcrete block are that the block can be many times the size of its clay and concrete equivalent. This course speeds up considerably the times spent laying a wall and it removes the necessity of purchasing or manoeuvring shuttering, especially if it would entail working in situations where access was restricted. (Allin 2005:74)

When casting blocks from hempcrete it must be remembered that the material itself must be remembered that the material itself is much heavier when it is wet and fragile as it has yet to set. The hemp blocks are better left dry before moving them. (Allin 2005: 74)

Once the blocks (Figure 10) have lost approximately 70% of its moisture content, hempcrete is quite suitable, so as long as handling is kept to a minimum as it is too fragile to be thrown about. The setting time is a factor that requires the blocks to be made at least a month or two in advance. (Allin 2005: 74)

Figure 17: Pre hemp block. (Allin 2005: 92)

The manner in which the blocks are stacked during drying time will need to ensure they do not adhere to each other. This is best achieved with a mesh layer between. (Allin 2005: 74)

The design of the block itself will vary to some extent with the dimensions required and the conditions provided for the curing process. Some versions have been made with spaces or holes through the block in order to provide an aperture for pipes or conduits to pass through; however it would be very difficult at times to attempt to line up such holes to enable any such services to be fed through at a later stage. It is easier to drill holes where and when you need them. Holes in the blocks created when they are being cast do however, help the blocks to dry out more quickly. (Allin 2005:74)

Ceiling panels, which can be used between exposed rafters, are manufactured presently. The panels are made with hemp hurd processed in order to contain a percentage of fibre, this acts as a reinforcement in the matrix of the hempcrete, which enable the panels to be cast in thickness down to 50mm. (Allin 2005: 74)

This mix of fibres and hurds must be kept to a certain balance, as too much fibre in the mix tends to form in clumps and this causes a problem with moisture. The lime and fibre mix in these clumps is too lime rich, due to the low surface area of the fibres. These fibres also act as a wick drawing the moisture into the hempcrete and keeping it wet for too long. (Allin 2005: 74)

The ideal proportions of fibre / hurds for the reinforcing element to work correctly is between 5-15% fibres of the volume of hurd. (Allin 2005:75)

The use hemp blocks effectively a different kind of timber frame is utilised. To avoid having to position the frame actually in the hempcrete wall, an inner frame is erected to support the floors and roof. The hemp block walls are then built up around this frame with the doorways and window frames built into the walls as they rise. (Allin 2005: 75)

To bond the blocks together a lime/sand mortar can be used and it is possible, with the right blocks and mixture of lime, to simply brush a jointing paste on to the blocks to produce a minimal joint with no thermal bridging. (Allin 2005: 75)

4.5 Finishes and details

- Window details

The creation of a window in the wall of a hemp building requires an effective method of shedding water at the lintel and at the sill. The style will of course depend on local climatic conditions, prevailing winds, rain, etc. (Allin 2005: 76)

From a design point of view it is a good idea to think of the windows of a house as the eyes and their dimensions and style will greatly affect not only the appearance of the building but the ambiance of the interior. (Allin 2005: 76)

- Door details

The detailing of a window or doorway is a very important aspect of the design of a building. With the hemp system it will be important to finish the hempcrete at this position in the structure in a manner not only suitable to the climatic conditions, but also to those of the skills of the craftspeople working on the job. (Allin 2005:77)

The frame needs to be strong enough to take the constant opening and closing of the door, and so will need to be rigid enough for this and the finishing of the reveals to the doorway need to be thought out to function correctly in order to shed rainwater or protect the corner of the hempcrete walls. (Allin 2005:77)

Several ways to do this can be employed with a number of different frame systems. The door may be set in an external frame so that the reveals are created by the timber, or the shuttering can be made to produce a hempcrete reveal which can be rendered in the normal manner. (Allin 2005:77)

- Lighting

To bring out the unique visual attributes of a room created using hempcrete, it is best to position the light sources so that they shine across the surface of the material to highlight literally the texture of the material. (Allin 2005:78)

This can be best achieved by either building a light into the surface of the hemp or by placing a free standing lamp in a suitable position. (Allin 2005:78)

In situations such as bathrooms and kitchens where there is likely to be a higher level of humidity than other rooms in the house, hemprecte works very well with the distribution of moisture and prevention of condensation. (Allin 2005:79)

On areas such as the splash backs of sinks or baths, tiles can be used to give an easily cleaned surface, provided a breathing lime mortar is used as adhesive and grout. (Allin 2005:79)

- Hempcrete Additives

In addition to purely hemp, limes and cements, other materials can be added to hempcrete to make it more suitable for particular applications or to change its appearance. (Allin 2005: 128)

To give hemp plaster colour throughout the material, pigments may be added. These can be natural mineral colours or man-made pigments such as acrylic ones used to colour printing inks. Mineral pigments tend to come as powders and should be mixed with water first and left to stand overnight in order to mix with the hempcrete without forming spots of pure undiluted pigment. Acrylic colours usually come as a liquid and should be diluted with water before being used. (Allin 2005:128)

To give hempcrete a harder surface or more thermal mass (but less insulation) sand or gravel can be added to the mix. If the hempcrete is to be exposed without a covering of plaster, the colour of the sand will affect the appearance of the hempcrete. (Allin 2005:128)

Some situations in a building will not be suitable for the use of hempcrete, such as under the floor of a “wet room” type of shower. In these situations it is better to use a material such as expanded clay which is lightweight but still breathes and can be used with a limecrete screed on the top of it. (Allin 2005:128)

Other materials added to the ingredients of hempcrete can be used to replace or supplement the basic ones, such as lime or cement. Pozzolans will speed up the setting time of the limes (they are available as ground volcanic ash from Pozzuoli in Italy) or crushed brick dust. They work by drawing carbon dioxide into the mix quicker than it would be normally. (Allin 2005:128)

Materials such as calcined clay, made from burnt china clay, will give the grinder element of the hempcrete higher density as the particles are smaller than some hydraulic limes. (Allin 2005:128)

- Tools for hemp plastering

Most of the tools used in hemp plastering are the same as those used with lime. Spot boards are set up near to the work at the right height so that the worker can easily take what they need without delays. The plasterer will take each trowelful off a hand held mortar board or hawk and apply it with a trowel or daubing by hand. (Allin 2005:137)

When applying with a trowel it is initially best to use a steel float or trowel for the material to slide off the tool surface, but to work it

smoother and flatter you will need a pointed wood or plastic float. The rectangular type is unsuitable as the corners catch the hemp particles and can cause the plaster to fall off. (Allin 2005:137)

Sponges and scrapers can be used when finishing and cleaning up around a job. (Allin 2005: 137)

In the hemp plastered surface is to be coated with lime plaster you will need lime plastering tools such as scratchers and specialized trowels for corners and hard to get to areas. (Allin 2005: 137)

4.6 Summary

There are many different techniques available to use hemp based building materials. May of these techniques is suited for South Africa as they are labour intensive. Not only the application of these materials, but the manufacture of the bricks and blocks are also labour intensive and can therefore create thousands of jobs.

4.7 Conclusion

The application of hempcrete, hemp plaster and hemp blocks are fairly similar to how conventional building materials are applied today. The different techniques which are available for example the spraying of the hemp plaster would need further training, but in South Africa where labour is readily available, the conventional application will be more likely applied.

4.8 Testing of Hypothesis

As stated in the introductory chapter, the hypothesis answer is the following:

- There will be a need to further educate skilled labour on the use and application of hemp building materials, but the general application of hemp building products is similar to

conventional construction methods therefore no training will be required. The tools used for the application of the hemp building materials will be very similar to the conventional tools used in today's construction

- The hypothesis is partially true and accepted. There are a few application methods which will require further training of skilled labour. The conventional methods of applying the hemp products may still be practiced without further training. The tools used for the application of the plaster are the same for conventional tools found on the construction site.

Chapter 5
Hemp in the South African Building Industry

What is the current knowledge, development and legalization of Hemp cultivation and the availability of hemp building materials in South Africa?

5.1 Introduction

Hemp and its uses have been investigated and researched for years, but not in South Africa. The countries which have legalised the growing of hemp, and which promote the amazing capabilities this plant has, and what hemp can be used for, have promoted the use worldwide. Hopefully in the near future hemp will be widely available in South Africa for use not only in the construction industry, but for the many other uses it has.

5.2 Research and knowledge

The cultivation of industrial hemp is in many ways very different from the cultivation of marijuana. Just looking at a field from a glance, one would be able to tell what crop it is. If the crop is being cultivated for seed, there is more space between the plants, which leads to more flowers. This produces flowers full of high-protein and EFA-rich seeds at harvest time. (http://www.hemporium.com Jun 2009)

If the industrial hemp is being cultivated for fibre, (Figure 11) there are over 200 plants per square meter. This will force the plants to compete for sunlight and grow straight up, often 3 or 4 meters high. This produces the desired long, strong fibres in the stalk. (http://www.hemporium.com Jun 2009)

Figure 18: Cultivation of hemp for industrial use.
(http://www.hemporium.com Jun 2009)

When hemp is cultivated for the psychoactive value, the plants will be well spaced out and kept as short shrubs, with many flowers. All male plants will be removed from the field as when pollination begins, the THC production slows done.
(http://www.hemporium.com Jun 2009)

The high THC secretion and low fibre content are characteristics of the plant commonly known as “dagga”. These qualities make the plant unsuitable for fibre production. However, the industrial hemp (Figure 12) is sought after because of its high fibres and the oil content. (Spicer 2002)

The South African Agricultural Research Council have been running trials for many years in order to identify which strains of the plant will grow well in the South African climate. (Figure 13) The strains which are being tested in this country are mostly the strains that come from Europe. (http://www.hemporium.com Jun 2009)

Figure 19: Fibre stalks of the hemp plant once processed.
(http://www.hemporium.com Jun 2009)

Figure 20: Cultivation of hemp for the rich fibre content.
(http://www.hemporium.com Jun 2009)

In 2002 the Institute of Industrial Crops researcher Catrien van Tonder said, “It would be a lucrative cash crop for communities if the results of the trials prove successful.”

Industrial hemp has a huge amount to offer South Africa. It is known that the plant will thrive in South Africa’s climate, and South Africa

has the potential to become a world leader in this industry. With the correct implementation and regulations, a hemp industry will help address economic, environmental and social issues. (http://www.hemporium.com Jun 2009)

Alone, hemp is not the solution to all the planet's ills, but is rather part of a growing trend, towards sustainable responsible living that could ultimately lead to a reverse in global warming and a greener, healthier planet. (http://www.hemporium.com Jun 2009)

The National Hemp Initiative, (of South Africa) is aimed at reducing poverty through stimulating profitable participation in the cultivation, processing, manufacturing and marketing of South African hemp. (http://www.hemporium.com Jun 2009)

"The products you will see this evening at the House of Hemp will surprise you in their diversity, ranging as they do from men's and ladies' fashion wear through to home decor, stationery, building materials and beauty and health products." (Ngubane 2001)

In 1999 South Africa took a bold step when it became the 27th country in the world to subsidise research into the commercialisation of industrial hemp. (Figure 12) South Africa now boasts a burgeoning hemp industry, with the promise of thousands of jobs, economic empowerment for our previously disadvantaged communities and the stimulation of the small business sector. (Ngubane 2001)

PG Bison and Masonite Africa, leaders in the South African building products industry, have provided funding to kick-start the hemp breeding program. A license has been granted by the Department of Health to grow hemp at Rustenburg in the North West Province. (Steven 1998)

"Demand for hemp products worldwide has increased by 233% over the past two years, and yearly South African hemp imports have grown from R500,000 to R1-million in the last year." (Wynn 2003)

"Given the recognised demand for fibre products, particularly tree fibre, and the limited availability of forest land in South Africa, the development of a viable hemp industry in South Africa will help boost the economy and empower rural farmers." (Wynn 2003)

5.3 Development and current projects

There are several projects currently underway in South Africa to research the viability of industrial hemp in South Africa. (http://www.hemporium.com Jun 2009)

The Western Cape Hemp Initiative has applied for 4 permits around the Western Cape. These permits are to bring about change and thereby contribute to the current solutions to poverty, economic development and nutrition. This will be achieved through the commercialization and industrialization of hemp in South Africa. (http://www.hemporium.com Jun 2009)

The most prominent project at this time is the '*Grow your own house'* project. An interview was held with Dr Ilse Trautman of Elsenburg College in the Western Cape, and the following is a summary of the project.

The Grow your own House Project is a pilot project of the NOPI, based in the Western Cape and developed within the framework of the integrated value chain for agri-fibres. The focus of this project is on the manufacturing of building construction material and handmade paper from industrial hemp grown in the Western Cape. As locally produced organic seeds are essential for the economic production of

industrial hemp, the project includes a separate project specialising in seed production.

This project is a cooperative initiative of several communities. It started initially with two communities, one from Sir Lowry's Pass and another from Zoar. As the communities engaged in a process of capacity building, it became clear that housing was a critical need in the Sir Lowry's Pass area, as in fact it is in the greater Boland area. The Sir Lowry's Pass community constituted themselves as the Sir Lowry's Pass Sustainable Development Initiative (SLPSDI) with the express purpose of ultimately addressing this housing crisis in their village. The community members however realise that there is more to sustainable development, than to simply supply low cost housing to their members. The leaders of the community are well aware that a change of paradigm in respect of the relationship of the human being to the environment is a critical element of sustainable development. Therefore elements such as awareness rising, environmental education, job creation, local organic food production and arts and crafts have been included in this community initiative. The existing tourist initiative in this village also played a major role in mobilizing the community. This initiative has now expanded to include The Phillipi Business Place as the proposed site to host the decorticator that will process the hemp and host the SME's that will produce the construction materials. The Stellenbosch Municipality has also offered land for a SIVA to base the training farm on.

The Klein-Karoo is a world renowned area for the production of excellent quality seed, the bulk of which is currently exported. To date there are no organically or bio dynamically certified emerging black seed farmers. The community in Zoar therefore identified seed production as a viable option for the sustainable development of their community. They constituted themselves as the Klein-Karoo Organic

Initiative (KKOI) and aim at producing organic seeds. The KKOI will also be the producers of the hemp seed required for the Grow your own House project.

The Grow your own House project involves the concept of growing industrial hemp as a rotational crop, processing it locally and producing construction material for housing development. This project will utilize the fact that the Western Cape is a major producer of lime, a critical input for production of hemp construction materials. The lime industry is one of the key links needed to hook into the Carbon Fund as lime production is a big carbon emitter. European lime manufacturers are interested in linking with Western Cape lime producers and these European companies will be the so-called "carbon Finance providers".

Being a NOPI project, the Grow your own House project shares the key objectives of the NOPI which can be summarised as follows:

- Create Sustainable and Integrated Villages for Agro-ecology (SIVA's) where the individuals and organisations that share a common goal, can work together to create their own small and medium enterprises in an integrated agro-ecology value chain (such as e.g. the hemp). The SIVA will provide a supportive environment by providing communal resources such as:
    - Administrative, logistical and infrastructural services
    - A pool of expert and skilled human resources and management
    - A community centre offering natural medicines and related care & healing
    - Village banks using alternative capital retention models and currencies
    - Training with dedicated follow-up support and care. Etc.

- Skill people to enable them to create small and medium sized up and down stream value chain businesses that service the primary agricultural producers and the community members of the SIVA, and qualify them as Master-Artisans
- Empower previously disadvantaged agricultural producers to become sustainable land stewards in a new paradigm of land stewardship ensuring that our country's natural resource base can be protected for future generations.
- Accelerate the land redistribution and agricultural reform program
- Implement the agricultural BEE-agenda, empower women and offer attractive employment to youth.
- Benefit from the access to capital investment via Carbon Finance. The NOPI is designed to qualify as a CDM project and the Grow your own House is earmarked to be the pilot agro-ecology project for the Environmental Fund.

One of the key strategies of the NOPI is that it builds its projects around an integrated value chain that has the best potential to allow sustainable development within a given context and locality. This has led to the identification of several cross-cutting value chains, all in line and synchronized to negotiate and engineer a shift towards the sustainable use of natural and renewable resources. Some examples of these value chain programs are:

- Bio-fuels (COBIFUBI - Community Bio-Fuels Beneficiation Initiative)
- Organic Seeds (NOSSA: National Organic Seed of South Africa)
- Agri-fibres (NAFI - National Agri-fibres Initiative)
- Indigenous Plant Products (SAMPPI - Scented, aromatic, medicinal Plants Production Initiative)

- Transport logistics (SAVATE - South African Vehicles Advanced Technology Evolution)
- Waste recycling (COWIMBI - Community Waste integrated Management Beneficiation Initiative)

Elements of all these value chains will be implemented in each SIVA with one of the programs forming the main thrust of the project. That SIVA therefore becomes a Centre for Production Excellence and Learning for the skills and technology related to that value chain.

The implementation of the Grow your own House project:
The NOPI program is implemented by a team of professional project managers from ICOFE. The management teams are formed from community level (SIVA project managers) through to international level. The style of management is communal. This means that all structures are managed through a collegial system, where participation is based on contribution and progress through workshops to exercise consideration, tolerance, respect, collaboration and harmony. The concept of “ubuntu” forms a foundation for all the work done. Management also operates on the basis of strict adherence to national policies and strategies in respect of BEE, gender equality, indigenous people’s rights, SME and job creation. All institutional mandates and protocols are designed accordingly. Workshops are facilitated by professionals on the premises of agendas decided by all. All production of tasks, reports, manuals, development plans must be reviewed by all before consumption.

The implementation of the NOPI is governed by a stake holder’s forum called SACODAS (South African Council for Organic Development and Sustainability). SACODAS is registered as a Section 21 company and has to date more than 60 members ranging

across the full spectrum of stake holders with interest in organic and sustainable development.

All constituents at all levels of championship, management, governance or implementation shall constantly enforce the above throughout the design, formulation, facilitation, engineering and management of their programs, commission or tasks.

- The structure of the ‘Grow your own House’ project:

The project is currently in a pre-planning phase. The technology and expertise for hemp construction is well established in Europe (France, Germany and Belgium being the leaders), but needs to be verified and adapted to SA. Research has been concluded to determine that industrial hemp can be grown in the Western and Eastern Cape. In July 2006, a high level visit from the Hemp Technology and Environmental Fund partners visited the potential production sites as well as the communities and area designated for the decorticator. They are satisfies that all criteria and indicators for success are in place and have indicated their willingness to engage with the project.

From December 2005 to September 2006, ICOFE has engaged in intensive negotiations with various seed, technology and skills partners in Europe, as well as with the French Environmental Fund. Everything is now in place to proceed with implementation once final agreements have been signed.

Therefore the 1st phase of the Grow your own House Project is focussed on completing the registration of the project as a CDM project and obtaining the necessary base line figures in the SA context to complete the detailed financial analysis and business

plans required for further implementation. As these projects are dynamic in nature, the exact formulations change as needed.

Currently a Western Cape Project Management Team exists with managers from the different communities (potential SIVA's) as well as a SACODAS representative on board. This team is responsible for the provincial level management and interface with the national management team. Community mobilization and capacity building is ongoing. Once the Provincial level agreements with the various government departments are in place, the communities will continue their engagement with their municipal LED officers and start planning for the 1st phase of implementation. (Trautmann 2009)

5.4 Legalisation

There are close to 40 countries in the world that have legitimised industrial hemp, including Canada, The United Kingdom, France, China, Germany and Hungary.
(http://www.hemporium.com Jun 2009)

In South Africa, the Department of Health controls the process of issuing research permits. This involves applying for a permit to possess a narcotic drug. (http://www.hemporium.com Jun 2009)

"Unfortunately the current situation is that there are no commercial permits in SA and only research, but we are hoping that all this will change with the new proactive role of our government. We are really working hard at this, as there is a big project on the cards called the "Grow Your Own House" Project, part of the NOPI."
(http://www.hemporium.com Jun 2009)

Any researcher or farmer wishing to grow and process hemp must be granted permits by both the health and agriculture departments, as well as the Medicines Control Council. (Figure 14)
(http://www.oak.cats.ohiou.edu May 2009*)*

Figure 21: Farmers and authorities working together to research the cultivation of the hemp plants.
(http://www.hemporium.com Jun 2009)

"As the council meets only once every six weeks, hemp-permit applications can get pushed aside for issues deemed of higher priority such as new medicines and health policies. A whole season can be missed because it takes months before a permit is cleared. This, in turn, affects potential foreign investment, as we require permits before funding can be secured. The existing legislation could cost the country its competitive advantage in this lucrative sector." (Wynn 2003)

In South Africa, there are efforts being made to get legislation amended in order to create a hemp industry. This is mainly in the Western and Eastern Cape. The main aspects that have been identified for further development are:

- Agri-fibres for car parts
- Eco-friendly paper
- Natural cement, bricks and insulation for housing
- Animal bedding
- Nutrition from the essential fatty-acid rich seeds

  (http://www.hemporium.com Jun 2009)

One appealing benefit of legalising the cultivation of hemp is job creation. Therefore by introducing this concept to this country, it may help to alleviate the three main issues in South Africa:

- Unemployment
- Malnourishment
- Lack of housing

(http://www.hemporium.com Jun 2009)

5.5 Summary

Much research has been conducted and the information has come vastly from foreign countries which currently cultivate hemp, and produce building materials from the fibre. Many companies are interested in getting involved with the production of building materials which boast an environmentally friendly quality.

There are current projects under way in South Africa which is promoting the use of hemp in construction. These projects are community based and are actually helping the communities with developing housing, community facilities, schools etc.

The legalisation has not been approved to cultivate hemp on a large scale, but trail crops have been cultivated to determine which strain of the hemp variety is most likely to be a successful crop in South Africa.

5.6 Conclusion

The current knowledge of hemp cultivation and processing is widely known among researchers and co-operates throughout South Africa. There are many uses of hemp, and therefore many different industries which are currently using hemp products. The development of cultivation and processing the plant into building products has been tried and tested, this has been helped by the foreign countries that have been using this plant for centuries. The legalization of hemp cultivation and the availability of hemp building materials in South Africa are still ongoing. Trails are still being tested, yet there a few projects currently underway in South Africa.

5.7 Testing of Hypothesis

As stated in the introductory chapter, the hypothesis answer is the following:

- The current research and knowledge is advanced in South Africa. There is little development and no current projects in South Africa. The legalisation in South Africa states that the cultivation of hemp is still illegal, but there are permits available for research purposes.

- The hypothesis stated is partially true and accepted. There is a fair amount of research underway in this country and a number of cultivation farms legally farming this plant. There are projects underway to develop this plant into a building material and it is currently being manufactured into construction materials which are being used. The cultivation of this plant without a permit is still illegal in South Africa.

Chapter 6
Conclusion

"*I have discussed how to build using materials derived from the hemp plant. However you cannot smoke the building or see the joints in the walls." (Allin 2005)*

Can the use of *Cannabis* (Hemp), when mixed with additives, be a suitable substitute to conventional building materials?

6.1 Introduction

For many years now architects and builders have been searching for alternative building systems and materials that achieve a lower environmental impact. Additional to this, they have been searching for systems that promote a healthier and more economic solution to the basic human need for shelter. Some of these ideas have come from adaptations of ancient and traditional techniques, others have grown from various uses of modern materials whether they were intended as building materials or not.

6.2 Environmentally friendly

The environmental aspects of cultivating hemp and the production of hemp building materials are beneficial to the environment.

Taking our environmental responsibilities seriously, the construction industry of South Africa should start to use hemp building products as a preferred building material. Hemp building products can actually reverse the damaging effects of greenhouse gases by locking up harmful CO_2 emissions. By using hemp building products, this will promote the farming of hemp, which is extremely beneficial to the atmosphere and the land.

6.3 Using hemp in construction

Professional consultants and contractors are prepared to change their conventional way of thinking, to strive to reach a *Green Star Rating* and use hemp building products in their design and construction.

The introduction of the Green Star Rating Tool in South Africa will benefit the environment and help to reduce waste and pollution on construction sites. By combining the rating tool and environmentally friendly building products such as materials containing hemp, could lead to a more “green” South Africa.

6.4 Education and training

There is no need to further educate and train skilled labour on the use and application of hemp building materials, and there aren’t any new tools for the application thereof.

The application of hempcrete, hemp plaster and hemp blocks are fairly similar to how conventional building materials are applied today. The different techniques which are available for example the spraying of the hemp plaster would need further training, but in South Africa where labour is readily available, the conventional application will be more likely applied.

6.5 Research and knowledge

The current knowledge, development and legalisation of hemp cultivation and hemp building products in South Africa are still fairly new.

The current knowledge of hemp cultivation and processing is widely known among researchers and co-operates throughout South Africa.

There are many uses of hemp, and therefore many different industries which are currently using hemp products. The development of cultivation and processing the plant into building products has been tried and tested, this has been helped by the foreign countries that have been using this plant for centuries. The legalization of hemp cultivation and the availability of hemp building materials in South Africa are still ongoing. Trails are still being tested, yet there a few projects currently underway in South Africa.

6.6 Conclusion

It is certain that hemp building products have been used worldwide with only positive results. It is now the South African local construction industries duty to take action and follow in the footsteps of countries that have been using hemp in construction for centuries.

In conclusion, the use of *Cannabis* (hemp), when mixed with additives, is a suitable substitute to conventional building materials. It proves to have excellent environmental benefits. Professional consultants and contractors are willing to utilise building products containing hemp in their design and in the construction of projects. The application of building products containing hemp is very similar to that of conventional products, and no formal training is needed to use the hemp building materials. There is ongoing research on this plant and the benefits of growing and using it as a main ingredient to many construction materials. There a few projects currently underway in South Africa due to the legality of cultivating the crop. Only farmers who have been granted permits may grow the plant.

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