Program & Abstracts

25 April 2017

Program & Abstracts Bamboo[st] 25 April 2017

Tuesday 25 April 2017 – Wageningen

08:00 hrs **Registration**

08:45 hrs **Opening and welcome Bamboo[st] 2017**

Session 1 - Bamboo diversity and versatility

Sponsored by van Nifterik

08:45-09:00 h	• Tjeerd de Vries, Ministry Foreign Affairs of the Netherlands - Kick off Bamboo[st] 2017
09:00-09:15 h	• Hans Friederich, INBAR - International development and the Bamboo triangle project
09:15-09:30 h	• Nellie Oduor, INBAR & KEFRI - Kenya Bamboo Project
09:30-09:45 h	• David Modijefsky, European Bamboo Society - Bamboo growing and production in NW Europe
09:45-10:00 h	• Ruud Goedknegt and Joep Meester, Barbarugo - Planting bamboo in the savanna's of Ghana
10:00-10:15 h	• Alex van Nifterik, Van Nifterik Holland bv - Bamboo uses in horticulture

Coffee break

Session 2 - Bamboo Textiles, fashion and design

10:40-11:00 h	• Coosje Hoogendoorn, KIT – Sustainable development of commodity supply chains
11:00-11:20 h	• Dr André Lehmann, Fraunhofer - Current and emerging technologies for man-made cellulosic fibers
11:20-11:40 h	• Peter Koppert, Modint - Sustainability criteria for textiles and fashion
11:40-12:00 h	• Simon Kos, Katja Buturlina, Royal bamboo – Timeless bamboo eco fashion
12:00-12:20 h	• Jayaraman Durai, INBAR - Multilateral Dutch-Sino East Africa Bamboo Development programme

Lunch

Session 3 - Bamboo in building applications: from poor man's timber to design

Sponsored by MOSO® bamboo products

13:20-13:40 h	• Arjan van der Vegte, MOSO- High end architectural applications of engineered bamboo products
13:40-14:00 h	• Stefan Krötsch, TU Kaiserslautern - Building with bamboo - an ecological alternative for Kenya
14:00-14:20 h	• Anna Caterina Rossi, ISO - Bamboo becomes international with ISO standards
14:20-14:40 h	• Marc Bokeloh, Bambooder - High performance bamboo composites
14:40-15:00 h	• Jiang Jingyan - The innovation and co-production of bamboo industry development in Yong'an CHINA
15:00-15:20 h	• Pablo van der Lugt, MOSO - Bamboo LCA, carbon footprint and sustainability

Coffee break

Session 4 - Bamboo in Food and Health Industry

15:40-16:00 h	• Pedro Fardim, KU Leuven and Carmen Boeriu, WFBR - Bamboo in health and cosmetics
16:00-16:20 h	• Liangru Wu, Jinlai Yang, China National Bamboo Research Center - Bamboo Shoots Sector In China: Encountering A Great Opportunity With Some Challenges
16:20-16:50 h	• Anke Janssen and Nam-Phuong Hua, WFBR - Bamboo food ingredients on the European market
16:50-17:10 h	• Bas Dunnewijk, Rettenmaier - Application of Bamboo fibres as nutritional and functional ingredient in food
17:10-17:30 h	• Jan van Dam, WFBR - Conclusions and wrap up - Bamboo and bio economy

Closure

WELCOME AT THE BAMBOOST CONFERENCE

Wageningen, 25 April 2017

JAN E.G. VAN DAM[1], (jan.vandam@wur.nl)

HANS FRIEDERICH[2] and OLIVER FRITH[2]

[1]Wageningen Food and Biobased Research (WFBR), The Netherlands

[2]INBAR, Beijing, China

Introduction

With the recent arrival in The Netherlands of two giant pandas named Xing Ya and Wu Wen the public interest for bamboo and bamboo products has been raised significantly. Agricultural production of bamboo in The Netherlands is not common practice, but it is essential to feed and satisfy the picky pandas. However, this conference is not about feeding endangered species, but rather about all potential uses of bamboo as an important bio-resource for sustainable developments for the endangered planet.

Bamboo is considered to be an ideal crop for rural development, especially in developing countries. Sustainable bamboo production and utilization is directly relevant to many of the UN sustainable development goals (SDG's) that are targeting important aspects of poverty reduction, housing and urban development, as well as use of renewable energy and combating climate change and land degradation [INBAR 2015].

Besides a wide range of food and health items for human consumption, many non-food products can be made from bamboo. Bamboo belongs to the most versatile and widely utilized plants, with many traditional applications varying from edible shoots, tooth picks, chop sticks, crafted baskets and matts, tools, musical instruments and artwork, to uses in horticultural crop support sticks, erosion control and soil protection or poor man's housing construction material. For the modern food and biobased industries, specific bamboo properties are very favorable for a wide range of applications, such as paper and pulp, cellulose in dietary fibre food additives or textiles, bio-chemicals and bio-energy. This conference aims to explore the potential of this abundant CO_2 neutral resource to supply future generations with essential products and basic needs.

Trilateral bambooo project East Africa

One of the reasons for this **Bamboost** conference is the trilateral project that was supported by the Dutch Ministry of Foreign Affairs and The Chinese Government to develop and transfer technologies for bamboo to East African countries Ethiopia, Kenya and Uganda. In the framework of this Dutch-Sino-East Africa project, the various species of bamboo available from these countries will be evaluated to assess the potential of the bamboos for commercialization and product development. For the various end uses the quality demands will be established of raw materials for processing into building materials, composites, cellulosic fibres (textiles, cellulose derivatives) and resins.

Based on the selection of te most suitable bamboo varieties for conversion to sustainable and economic marketable products, demonstration test will be performed on the manufacturing at lab scale for bamboo composite products; bamboo based resins and bamboo as raw material for textile yarn production

This Programme will build on Chinese and Dutch expertise in bamboo value chain development, product design, marketing and standardization to support Sub-Saharan African countries to unlock the vast potential of the continent's indigenous bamboo resources for green economic growth, trade and poverty reduction.

Over the last 30 years, technology and policy innovations in China, have seen bamboo, one of the world's fastest growing plants and a highly versatile material, rise to play an increasingly important role in the emerging global bio-economy. To date, annual international trade in bamboo products ranging from traditional crafts and furniture, through to pulp and paper, composites, structural materials, biomass energy and even textiles, has reached US$2 billion, with the sector helping increase forest cover, restore degraded lands and mitigate climate change. Bamboos' emergence in European markets, led by Dutch expertise in design, standardisation and marketing, has provided consumers with new greener alternatives to tropical hardwoods and conventional industrial materials.

At the same time, due to its lightweight, relative ease of processing, and fast growth, the bamboo sector helps millions of people in poor marginal areas participate in value chains and escape from poverty. However, to date, despite having 12% of the world's global bamboo resources [FAO 2010], Africa accounts for just 1% of international trade [INBAR 2014]. Therefore, via triangular cooperation, Africa can begin to realise the full potential of its local bamboo resources.

One added benefit is that planting bamboo on degraded soils can help reduce erosion and promote the restoration of the landscape. China has extensive experience in large-scale land restoration, and has created 3 million hectares of bamboo forests and plantations during the past 30 years. South-South collaboration can help to restore some of the unproductive, marginal lands in Africa.

The programme focuses on INBAR Member States in East Africa, Ethiopia, Kenya and Uganda, which are countries earmarked for Dutch assistance in poverty reduction and trade development.

Finally, in Africa, there is great demand for development and trade cooperation on the bamboo sector. The Continent is already INBAR's largest member bloc, with a number of member countries, such as Ghana, Nigeria, Rwanda and Ethiopia also having dedicated national programmes and policies to support the sector in place. A small formal African bamboo private sector is starting to emerge, but African partners still require significant technical, financial, and policy assistance to help them upscale and improve the quality of products so that they can access domestic and export markets.

Ministerie van Buitenlandse Zaken

The support of the Dutch Ministry of Foreign Affairs to organize this **Bamboost** event is gratefully acknowlegded.

INTERNATIONAL DEVELOPMENT AND THE BAMBOO TRIANGLE PROJECT

HANS FRIEDERICH (hfriederich@inbar.int)
INBAR, Beijing, China

INBAR is the only Treaty-based international Inter-Governmental Organisation that deals with bamboo and rattan. We are 20 years old, and currently represent 42 Governments.
The global Headquarters are in Beijing, China and we have 4 Regional Offices in India, Ethiopia, Ghana and Ecuador.

Our strategy aims to help countries develop their bamboo and rattan resources within the context of sustainable development, and we are using the 2030 development agenda and the 17 Sustainable Development Goals as the basis for involvement.

We have launched the Global Assessment of Bamboo and Rattan (GABAR) to help countries determine what bamboo and rattan resources they have, and to assist them in the sustainable management and development of these resources. GABAR was launched in 2015 with highpolitical support, and has so far produced a number of guidance reports as well as several national and sub-national assessments. Later this year, we will produce the first inventory maps, and more guidelines and national studies.

Most of what we do involves South-South Cooperation, and we work with key partners like the UN Office for South-South Cooperation and the China Belt-and-road initiative. We also manage a number of South-South and trilateral projects in Africa, Asia and Latin America.

We believe that bamboo can help nations in the Global South reach several of their Sustainable Development Goals, and South-South Cooperation is an effective way to support this.

THE KENYA BAMBOO PROJECT

NELLIE ODUOR, (noduor@kefri.org)

National Bamboo Programme Coordinator,
Dutch-Sino-East Africa Bamboo Development Programme

INBAR & KEFRI

The Kenya Bamboo Project is part of the Dutch-Sino-East Africa Bamboo Development Programme being implemented in Ethiopia, Uganda and Kenya. The programme's overall objective is to contribute to green economic growth and international trade and investment between East Africa, Europe and China. The programme has two specific objectives and three results areas. The specific objectives are: to develop pro-poor industrial value chains for bamboo in East Africa with Dutch and Chinese expertise that will generate benefits for African, European and Chinese investors and consumers and secondly to restore degraded lands in Africa and contribute to climate change mitigation. The result areas are: (i) Reduced poverty & green economic growth secured through the development and improvement of industrial bamboo value chains in East Africa (ii) Increased international trade and investment between Europe, East Africa and China, with growing domestic markets in East Africa and (iii) Restore Land and Mitigate Climate Change. This paper will look at the results areas and the progress made since the inception of the programme in December 2016 and the activities planned for in the 1st year.

BAMBOO GROWING AND PRODUCTION IN NW EUROPE

DAVID MODIJEFSKY (secretariaat@bamboepagina.nl)
European Bamboo Society

Bamboo Growing & Production in Europe

David Modijefsky, Secretary | EBS The Netherlands

Sustainability

Sustainability is a broad subject. When we only look at growing and production, the options are limited.

Situation in Europe

Europe's biggest handicap when it comes to growing industrial bamboo species is our climate. It's either too cold/too wet or too hot/too dry. Farmland is expensive so bamboo is passed by easier growing plants.

Markets

Most EU countries only serve the horticultural market. Nurseries produce in greenhouses and in soil. Sustainability is not high on the agenda as margins on the plants are thin. But there are a few sustainable examples of interest.

- First EU certified bamboo nursery produces fully biological grown plants
- Greenhouse nurseries with a closed water circuit
- Use of predatory mites instead of pesticides
- Nurseries that fully run on collected rain water
- Wastewater management

Excellent, but there's a bigger potential. If we also look at the application of the plants we grow, we have a lot more options. We define a new category called 'Living Industrial'. Examples are

- Noise barriers
- Dust collection in harbours, sand bunkers, etc
- Living fences around parking garages
- Stabilising soggy fields
- CO2 absorption along highways

Experimental climate

Many obstacles have to be overcome to create a decent climate for bamboo experiments. At the moment bamboo faces a lot of prejudice.

Chances

There are opportunities for bamboo in situations where it has a competitive edge or where it's the better solution. A few interesting experiments and options are

- *Phyllostachys bambusoides* (Madake) grown on sawdust mixture without additional watering
- *Phyllostachys edulis* 'Bokrijk' grown from seeds in EU, now winter-hardy

Conclusions

- Bamboo can play an important sustainable role in Europe
- Europe can have it's own industrial species
- Conditions for experiments should drastically improve
- Growing demand for biological grown plants (retail + consumer)

PLANTING BAMBOO IN THE SAVANNA'S OF GHANA

RUUD GOEDKNEGT[1] (ruud.barbarugo@gmail.com),
and JOEP MEESTER[1] (joepmees@telfort.nl)

Many hectares of wild and arid grounds, where only during the rainy season spear grass and elephant grass will grow, are now being cultivated by the Stichting Barbarugo. This means that all the weeds and old tree trunks are removed and, dependent on the species of bamboo, 150 to 400 holes (/ha) are dug. The holes are 40cm wide and deep and get filled with soil, fertilizer, humus and compost.

At the start of the rainy season a single bamboo plantlet is put in each hole which is then nurtured by watering and weeding when necessary. These shoots come from our own nursery in Kintampo where they have been multiplied from the original imports from BNV in Indonesia. We are working and testing with 8 species: 4 types of *Bambusa*, 2 types of *Dendrocalamus*, *Gadua amplexfolia* and *O. abyssinica*. We made this selection based on several criteria: the bamboo has to withstand a 5 month period of drought, there is a great variation of soil and every type of bamboo has its own application from building materials to making charcoal.

In 12 villages, spread across North Ghana, bamboo plantations are in operation or being prepared. The oldest one, from 2013, is in Suamire near Kintampo. The culms are over 15m high and the clumps have grown to over 30 poles. The fastest growing *B. bambusa* will be harvested this year for the first time. The culms will be dried and shredded and sold to a factory in Assin Fosu. Next year the stronger species will have their first small harvest and Barbarugo is in contact with Ghanaians that intend to start a factory for building materials and furniture.

In North Ghana about 1M illiterates live in absolute poverty because there is no work. The aim of Barbarugo is to let these people work on the land, maintaining the bamboo but the first problem is to motivate them. Barbarugo micro-finances the plantations for the first 5 years after which the revenues will slowly start to come in. At first nobody had any faith in the project because it was assumed that nothing would grow in that dry climate with its destructive sand storms. Even the University of Kumasi strongly advised against the project but we were able to convince 2 village chiefs to give us land to use. Now that we have shown that the selected species of bamboo can grow in these circumstances the villages chiefs are queuing up to start a plantation and we have a waiting list. As we are very short of finance we have to disappoint them for the time being.

Apart from the fact that our project fights poverty and unemployment there is another important effect of planting bamboo: the foliage will improve the local climate and the temperature becomes more bearable. The shadow the bamboo provides makes the rain drop onto and into the ground and not directly evaporate, thereby refilling old handdug wells.

The area that we have in mind (150km x 200km = 3Mha, about the size of the Netherlands) is large enough to compensate for all the Dutch CO_2 (160Mton/year). We hope and fully expect that nature will return in these savanna's that less than 200 years ago was all woodland but have been devastated by the local population in search of firewood.

BARBARUGO

[1]**Stichting Barbarugo** and our local partner **Barbarugo Ghana NGO** is bringing back nature. As we are fully dependent on private donations your gift will be highly appreciated:
NL05 RABO 0174 9693 41 - Stg Barbarugo in Waverveen.

BAMBOO USES IN HORTICULTURE
Bamboo wants to join us together!!

ALEX VAN NIFTERIK[1] (alex@vannifterik.com)

Conclusions of twenty years of experience with trade in bamboos for horticultural use, are the following:

The first point relates mainly to the Tsinglee canes, which we bought in particular in the Chinese areas of Guangning and Aozai. The fact is that bamboo seems to be ineradicable. But decline of quality and product consistency over the years is observed and certain types do run the risk to disappear due to mismanagement of the areas of natural bamboo stands and the harvest of too young stems!!

Some bamboo varieties seriously do run the risk to disappear!

The second point I would like to mention is closely related, and also a widespread phenomenon. There is too much focus on short-term thinking and acting in the (Chinese) bamboo supply chain. Lack of proper maintenance, investments in harvesting equipment and increasing costs of labour are causing shortage and rising prices of good quality bamboos. Doing business in China requires a flexibility like that of bamboo!

A third point is that the sustainability of bamboo is not adequately valued by our customers. Compared with other products that could be suitable as a support stick, bamboo is by far the best when it comes to flexibility and weight. But there are also issues such as bamboo rotting and splitting, which is a serious problem, as well as the growth of mildew on flower sticks. The use of alternative support sticks (fibre glass, pvc, metal tubes) also has disadvantages, but are not based on renewable and CO_2 neutral sources.

In conclusion, by sharing the experience and concerns of bamboo supply I hope to contribute to the proper appreciation of bamboo by joining customers and local producers to do investments in the supply chain for sustainable bamboo.

[1] Van Nifterik Holland bv, Ede, The Netherlands

SUSTAINABLE DEVELOPMENT OF COMMODITY SUPPLY CHAINS

J. COOSJE HOOGENDOORN[1] (c.hoogendoorn@kit.nl)

Throughout a commodity supply chain people are at the centre of the uptake of innovations. Therefore income, education, gender and age, amongst others, are important for understanding and enabling the uptake (or not) of technology, and similarly environmental and economic interventions.

Research carried out by KIT and partners has shown that successfully scaling interventions in agricultural commodity chains depends on how local actors are involved. For example, a balance between higher risk 'experimentation' activities and lower risk 'bringing into routine use' activities is recommended. Likewise it is important to assure that implementers get and take the necessary room to react to emerging opportunities and experiences.

Each commodity supply chain is different. Nevertheless, all commodity supply chains also are similar. Lessons learned about interventions in one supply chain can support more effective supply chain development interventions for another commodity.

Interventions aimed at sustainable development of the bamboo supply chain offers particularly exciting opportunities for small and medium sized operations, poverty reduction, and environmental sustainability, which can be inspired by and shared with other supply chains.

Examples from commodity supply chains, in particular from Ethiopia, and including bamboo, will be compared to highlight options for optimized enabling and scaling of bamboo supply chains impacting smallholder farmers and small and medium sized operations.

[1]KIT - Royal Tropical Institute, Amsterdam

CURRENT AND EMERGING CELLULOSE REGENERATION TECHNOLOGIES

ANDRÉ LEHMANN[1], (andre.lehmann@iap.fraunhofer.de)

Cellulose, the most abundant renewable organic material on earth, exhibits outstanding properties and useful applications, but also presents a tremendous challenge with regard to economical and environmentally friendly chemical processing.

The viscose process, more than 100 year old is still the most widely utilized technology to manufacture regenerated cellulose fibers and films. Viscose fibers are produced today worldwide on a 5 million ton scale with various fiber types ranging from high performance tire yarn to textile filaments and staple fibers with excellent properties close to those of cotton. Despite its broad utilization and the wide variety of fiber properties attainable with the viscose process, some environmental problems such as sulfur and heavy metal emissions have to be tackled. As industrial alternative to the viscose route for shaping cellulose from solution, the so called Lyocell process is performed in a scale of roughly 220 kt/a. The non-derivatizing route uses N-Methylmorphoine-N-oxide Monohydrate as a solvent. The different spinning solution properties cause different spinning technologies in comparison to the viscose route and results even in different fiber structures and therewith finally in different fiber properties.

The presentation will give an overview on the commonalities and differences of both industrial used processes and further on present possible emerging technologies for shaping cellulose from solution.

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SUSTAINABILITY CRITERIA FOR TEXTILES AND FASHION

PETER KOPPERT[1] (koppert@modint.nl)
Modint

Sustainable Materials Guide

Nowadays it is difficult for companies to get a grip on sustainability because there is an overload of information available. This is the reason that Modint developed a guide for buyers, product developers, designers, as well as manufacturers and all other parties that would like to lower the ecological and social impact of their materials. We understand that it is hard to make decisions in the field of sustainability. It is difficult to define the impact of a material and all wet processing related to it. At the same time, a lot has happened; the oil prices went down by 70% between July 2014 and January 2016. It was suddenly more difficult for recycled polyester to compete with prices on virgin polyester. A similar effect is observed for biobased products. Next to that there is a huge discussion on microplastic issues in the ocean and last but definitely not least, the unrest in the world and climate change has major impact on (organic) cotton production. With the Sustainable Materials Guide, we want to help companies to develop basic knowledge and to develop their own vision and goals to create a sustainable collection. Companies can use our practical tips & tricks and refer to the tools we mention to start a dialogue with their suppliers.

[1]MODINT Trade association for fashion, interior design, carpets and textiles Utrechtseweg 95 | P.O. Box 428, 3700 AK, ZEIST, The Netherlands www.modint.nl Tel +31 30 232 09 61 | Mob: +31 6 12765319

MULTILATERAL DUTCH-SINO EAST AFRICA BAMBOO DEVELOPMENT PROGRAMME

JAYARAMAN DURAI (jdurai@inbar.int)
INBAR

East Africa's bamboo sector remains largely untapped, despite the region having sub-Saharan Africa's largest natural bamboo forests and accounting for around 3-4% of the world's total known bamboo coverage. Low value products and a lack of capacity to adhere to international standards has resulted in Ethiopia, Kenya and Uganda's exclusion from global export trade in bamboo products already valued at over US$1.8 billion, while their domestic markets remain under-developed.

The Dutch-Sino-East Africa Bamboo Development Programme will build on and transfer Chinese and Dutch expertise in bamboo value chain development, product design; marketing and standardization to support East Africa unlock the vast potential of its indigenous bamboo resources for green economic growth, trade and poverty reduction. Thus enabling Ethiopia, Kenya, and Uganda to fully participate in and benefit from the new bamboo economy of the 21st century.

The *overall objective* of this triangular programme is to contribute to green economic growth and international trade and investment between East Africa, Europe and China.

The *specific objective* is to develop pro-poor industrial value chains for bamboo in East Africa with Dutch and Chinese expertise that, in the long-term, generate benefits for African, European and Chinese investors and consumers;

A second *specific objective* is to restore degraded lands in Africa and contribute to climate change mitigation.

The presentation will illustrate on the rationale, participating countries and regions; partners and stakeholders; activities, outputs and expected results of the programme.

HIGH END ARCHITECTURAL APPLICATIONS OF ENGINEERED BAMBOO PRODUCTS

A. VAN DER VEGTE[1], (avandervegte@moso.eu)

Bamboo reaches an incredible hardness and its extraordinary properties offer many possibilities in the construction business. It is many times stronger than oak or the still popular but endangered tropical hardwoods. Bamboo has evolved in recent years into a much sought-after engineered product. Nowadays parquet floors, stairs, wall and ceiling coverings, door panels, beams, furniture and much more is created with this millennial commodity. Who would have thought that a grass might be an alternative to hardwood or tropical timber?

Being a relatively new material in the conservative building industry, bamboo does not always have the certifications that are available for traditional building materials. MOSO has taken the lead to acquire all relevant certifications for industrial bamboo products relating to the environment, health and quality, including the development of separate EU standards for bamboo. As a result of these certifications, application of MOSO bamboo products (flooring, panels, beams, veneer, decking & cladding) can even lead to a higher score for LEED and BREEAM, the leading green building certifications worldwide. Latest product developments aim for more architectural applications: with bamboo beams for indoor and outdoor semi-structural use and extremely durable flooring that outperforms most other natural alternatives.

MOSO International B.V., established in 1997 in the Netherlands, specializes in the development of innovative and sustainable bamboo products for interior and exterior applications. MOSO is a global player that operates from its headquarters in Zwaag, the Netherlands, and offices in China (Hangzhou), Spain (Barcelona), South Africa (Cape Town) and Italy (Milan). With its extensive experience and focus on innovation, MOSO can meet the highest customer requirements and has become the European leader in high-end industrial bamboo products.

[1]MOSO Research & Development Center, Zwaag, the Netherlands

BUILDING WITH BAMBOO – AN ECOLOGICAL ALTERNATIVE FOR KENYA

STEFAN KRÖTSCH[1], (stefan.kroetsch@architektur.uni-kl.de)

Kenyas indigenious bamboo *Yushania Alpina* covers large areas of the Aberdares, Mt. Kenya, the Cheranganis, Mt. Elgon and the Mau. The many benefits of theses bamboo forests like soil stabilisation, water catchment and biodiversity are endangered since the forests are widely replaced by cash crop plantations like tea or tobacco. The potential of utilization of bamboo and it‘s positive side effects for rural economy and preservation of environment is not yet recognized in Kenya.

The project of the Skills Centre in Malaa near Nairobi addresses the benefits of using simple but sophisticated bamboo constructions made of natural canes, utilizing the materials structural qualities as much as it’s light weight. Structural elements with a length of 12 meters were easily prefabricated by local workers with standard tools and assembled within a few days by only five workers without crane or other lifting equipment.

The example of the skills centre shows bamboo to be a very suitable and environmentally friendly substitute to construction materials like timber or steel in Kenya and at the same time is much more cost efficient. If all parts of the bamboo structure are protected from moisture, a durable, long lasting construction can be established. Modern design for contemporary tasks can be realized.

The indigenous *Yushania Alpina* is a very qualified building material. At the same time, using *Yushania* from sustainable forestry and plantations helps to save and replant the natural vegetation. This way wildlife can be preserved, water catchment can be improved and local rural communities are able to benefit from natural, renewable resources. Building with bamboo offers the chance for Kenya to not only utilize an important part of its natural and by sustainable use endless resources, but at the same time to develop an industry within a market of high expectations.

[1]Jun. Prof. Dipl.-Ing. Technical University of Kaiserslautern, Germany

BAMBOO BECOMES INTERNATIONAL WITH ISO STANDARDS

ANNA CATERINA ROSSI[1] (rossi@iso.org)

ISO is the International Organization for standardization: it develops International standards that are recognized by the World Trade Organization as meeting the requirements of the Technical Barriers to Trade agreement.

ISO members are the national standards bodies of 163 countries all over the world: a good percentage of these are developing countries. To strengthen and to increase their participation in ISO technical committees, there are special provisions such as the twinning arrangement, participation to meetings via web and also sponsorship for experts to attend physical meeting.

In 2015, ISO established a technical committee dealing with bamboo and rattan, ISO/TC 296: although works just started, there are already three active work items in its work programme, all dealing with bamboo – for the time being! – and rattan will also soon be covered. Considering that bamboo and rattan producers are mostly in developing countries, it is extremely important that experts from these countries actively participate to the elaboration of International standards.

Other technical committees dealing with bamboo are the committee on timber structures, ISO/TC 165, that has published three standards on bamboo structures, and the committee on wood-based panels, ISO/TC 89.

The elaboration of an International standards usually takes about 3 years: the process makes sure that all interested parties are involved, meaning all the stakeholders for the special field, coming from the major market players countries. A draft standard is first elaborated by a group of experts and then circulated to all ISO members first for commenting and then for final approval.

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HIGH PERFORMANCE BAMBOO COMPOSITES

MARC BOKELOH[1], (info@bambooder.nl),
DELPHINE DEPUYDT[2], and AART WILLEM VAN VUURE[2]

Bamboo grows fast, is abundantly present and can be harvested annually without depletion or degradation of the soil. Besides these interesting ecological characteristics, bamboo and especially bamboo fibres have good mechanical properties. For a long time research on bamboo fibres has been hindered due to difficult extraction of the fibres. In previous research, conducted by KU Leuven, a unique mechanical extraction process has been developed, resulting in the extraction of high quality fibres. The virtue of the extraction process is reflected in the superior mechanical fibre properties: stiffness between 45-55 GPa and a tensile strength between 500-800 MPa. Combined with the low bamboo fibre density (1.35-1.40g/cm³), it is clear that bamboo can rival with traditional glass fibres. This motivates the research on bamboo fibres as a natural reinforcing fibre in composites. Bambooder has extensive knowledge in the production of short bamboo fibres and has now developed another technique to produce long bamboo fibres. Together with KU Leuven the material was analysed and compared in order to determine adequate applications. The results are promising as the tensile fibre stiffness of the Bambooder fibres is 49 ± 10 GPa with a strength of 530 ± 115 MPa. Also the transversal properties showed no significant difference between the two extraction methods. Another material that has been investigated is referred to as 'crushed bamboo'. The bamboo material is crushed and impregnated with epoxy. Compared to the composite with bamboo fibres the stiffness is 33 % lower and the strength 64 %. Also the transversal three point bending strength is 33 % lower. Bambooder focus is to scale the production and define and process applications.

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[2]KU Leuven, Belgium

SUSTAINABILITY OF INDUSTRIAL BAMBOO MATERIALS

P. VAN DER LUGT[1,2](pvanderlugt@moso.eu)

This study assesses the carbon sequestration potential through the increased use of industrial bamboo materials in the Western building industry, to better understand how engineered bamboo compares with commonly used building materials such as tropical hardwood.
The first objective of this study is to measure the environmental impact of industrial bamboo products and its production process in terms of their CO_2 equivalent (carbon footprint). The second objective of this paper is to clarify how carbon sequestration on a global scale, including in bamboo forests and plantations, can be defined and calculated for industrial bamboo products, and how they can be incorporated in the standard carbon footprint calculations.
The study concludes that industrial bamboo products, if based on best-practice technology (production chain of MOSO International BV), even when used in Europe, can be CO_2 negative over their full life cycle.

[1] MOSO Research & Development Center, Zwaag, the Netherlands
[2] Delft University of Technology, Faculty of Architecture & the Built Environment, Climate Design & Sustainability, The Netherlands.

BAMBOO IN HEALTH AND COSMETICS

PEDRO FARDIM[1],(pedro.fardim@kuleuven.be) and
CARMEN BOERIU[2], (carmen.boeriu@wur.nl)

[1]KU Leuven, Belgium
[2]WFBR, The Netherlands

Bamboo has a long tradition of utilisation in the daily life of humans. Applications cover a broad area, from industrial uses in constructions, fabrics and biofuel to nutritional applications of edible juvenile shoots and utilisation to promote health and well-being. Traditionally used in Chinese and Indian medicinal recipes, health benefits of bamboo are now extensively studied to bring the scientific evidence of the claims and to identify the bioactive components generating them. Recent research revealed a number of bioactive and health effects of bamboo extracts, like antioxidant, anti-inflammatory, anti-fungal, anti-microbial, cholesterol lowering and antihypertensive properties. Also, bioactive components associated to these properties have been identified, such as terpenes (carotenoids, phytosterols), phenols (lignans, flavonoids), saponins, fibres, minerals (organic silica particles), etc. This review will discuss the pretreatment, fractionation and purification of (bio)active components from bamboo shoots including challenges and opportunities and potential health and cosmetic applications.

BAMBOO SHOOTS SECTOR IN CHINA: ENCOUNTERING A GREAT OPPORTUNITY WITH SOME CHALLENGES

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Bamboo, specially with two main products of bamboo timber and bamboo shoots, is one of the earliest non-wood natural resources developed and used by human beings. Bamboo shoots are rich in protein, high in fiber, low in fat and calories used as a delicacy in human food. With a good reputation both in domestic and international market, China has achieved rapid development of bamboo shoots sector in the past thirty years. This article briefly introduced the bamboo shoots resource in China, and the nutritional and medicinal value of bamboo shoots. An analysis and classification was taken upon the history and achievements of bamboo shoots cultivation and utilization in China. The emphasis was put on the problems and chances on the development of bamboo shoots sector in China, in order to promote further progress. In a summary, the suggestion and orientation of the bamboo shoots sector were proposed for China and world.

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EXTRACTION AND FUNCTIONAL PROPERTIES OF FOUR TYPES OF PROTEINS FROM MOSO BAMBOO SHOOTS

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Bamboo forest mainly produces two products: culms and shoots. Moso bamboo covers an area of 4.43 million hm^2 in China, which offers abundant shoots. Moso bamboo shoots, regarded as one of mountain delicacies, are rich in nutrient components of fiber, proteins, amino acids, carbohydrates, minerals, and phytosterols, but low in fat and sugars. Albumin, globulin, gliadin and alkali soluble protein with a content of 45.32%, 21.54%, 7.92% and 19.11%, were successfully extracted from Moso bamboo shoots. There were 8 essential amino acids for human body and albumin offered a content of 12.02%. After that, their functional properties were further studied. The hydrophobicity of four proteins was provided, gliadin> alkali soluble protein> globulin> albumin. At a neutral condition, albumin had the best solubility. Meanwhile, albumin and globulin possessed a high water holding capacity of 4.2 and 5.0 ml/g while albumin and gliadin offered a good oil absorption volume of 3.6 and 3.2 ml/g. The emulsification ability of albumin, globulin, gliadin and alkali soluble protein were 35.8%, 29.2%, 22.1%, 14.2%, which gave a stability of more than 65.1%. Albumin had the best foamability of 67.7% and provided a 48.6% foam stability. The four proteins will have a potential application in the food industry.

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BAMBOO FOOD INGREDIENTS ON THE EUROPEAN MARKET: Potential of fresh bamboo shoots in the Dutch kitchen

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Fresh bamboo shoots are consumed widely in Asia and in parts of Africa. Fresh bamboo shoots have a high nutritional value compared to more conventional vegetables and also have multiple health benefits. Therefore fresh bamboo shoots are a valuable addition to the human diet. Many food products do contain processed bamboo or ingredients derived from bamboo: e.g. bamboo fibres are being used as functional ingredients to e.g. improve texture or water binding capacity of the food product. However, currently fresh bamboo shoots are not available on the Dutch market, also consumer demand for it is small. Dutch consumers are not yet very familiar with eating (fresh) bamboo and its benefits.

In the Netherlands, cultivation of fresh bamboo shoots as a food crop is technically possible but hardly feasible. The unfavourable Dutch climate would result in small shoots which makes the production process inefficient and not very cost effective. Production in greenhouses is economically unattractive. To import bamboo shoots from tropical regions such as East-Africa, with a climate suited for bamboo production, might prove to be a profitable and viable concept. Also, production of bamboo in East-Africa potentially will have multiple socioeconomic benefits. A major restriction to import fresh bamboo shoots to the Netherlands is their limited shelf life. Also, fresh bamboo shoots contain taxiphyllin which is the precursor to hydrogen cyanide. To be able to successfully introduce fresh edible bamboo shoots to the Dutch market, it is important to find convenient processes to reduce this toxicity.

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BAMBOO FIBRE: AN INNOVATIVE NUTRITIONAL AND FUNCTIONAL INGREDIENT IN FOOD

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Bamboo fibres are a source of dietary fibres. Dietary fibres are substances that can't be broken into resorbable parts by the enzyme system of the human body.

The addition of isolated dietary fibres is highly appreciated in modern food formulations. Besides known insoluble fibres from different cereals and vegetables, bamboo fibres are becoming more and more popular, because of its attractive characteristics:

- High fibre concentrate, up to 97%
- White, taste and odorless
- E number- and allergen free
- Water retention in the capillaries up to 700%
- Environmentally friendly

The WHO advises a daily intake of 35-40 grams of soluble and insoluble fibres. The awareness by consumers that dietary fibres have an important role in preventing lifestyle diseases like diabetes 2 and obesity is rapidly growing. Bamboo fibres can, in combination with a soluble fibre source, play an important role in fibre enriched food. In reducing the caloric load in bakery or meat products, bamboo fibres can play an important role.

The functionality of bamboo fibres can widely be of use in a range of food preparations:

- Using the hydrophilic and lipophilic properties give structure and bite
- They assist in reducing drip / syneresis and other weight losses of food products
- Synergistic effect with hydrocolloids and proteins
- Anti-caking and free-flowing effect in fatty powders
- Carrier and bulking agent

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CONCLUSIONS AND WRAP-UP

BAMBOO AND THE BIOECONOMY

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In conclusion of this **Bamboost** conference we hope to have shown the great potential of bamboo as versatile and sustainable source for the bio-economic development and its relevance to many of the UN sustainable development goals (SDG's). As bamboo is one of the fastest growing crops it is more efficient than trees for conversion rates of CO_2 to biomass (e.g. lignocellulose) and it has the potential to reclaim degraded land, when properly mananged. It can be coverted to a wide range of economic uses from delicious food to fashionable clothing, design housing, green chemicals and fuels. With the increasing scarcity of forest products and rising prices for wood, the potential of bamboo as non-timber source has been recognized for production of paper pulp and higher added value products such as dissolving cellulose for the production of regenerated textile fibres or cellulose derivatives.

The use of bamboo as substitute for wood in building products has been successful to a certain extend and novel designs for furniture and flooring elements are promoted on markets worldwide and especially in developed countries. The use of phenol and formaldehyde free alternative resins for manufacturing of ecologically improved bamboo composites is one of the identified needs to increase the market acceptance. These may be achieved by alternative methods for biorefinery of bamboo to produce more or less purified cellulose, lignin and pentosan, which have been explored for their uses at WFBR and will require further exploration for industrial implementation.

Promotion of international cooperation between experts and stakeholders of many disciplines will be required to to convert bamboo to a sustainable commodity for future generations.

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