

the sustainability of **MOSO** bamboo

m_{oso}®



the sustainability of MOSO bamboo

The continuous destruction of tropical forests for timber production has a significant influence on global warming and leads to a worldwide decrease in biodiversity. MOSO Bamboo products combine the virtues of the best hardwoods (hardness, looks, stability) with the immense growing capacity of the highly renewable giant bamboo species Moso and can therefore act as the green carbon negative alternative for scarce (tropical) hardwood and in some applications even for high CO₂ emitting products made from non-renewable resources such as concrete, plastics (PVC) and metals (aluminium, steel).

All too often companies claim to have a green product, they are however usually not able to back up their claims. At MOSO we want to be transparent. We only base our claims on scientifically based reports following latest environmental assessment methodologies (e.g. carbon footprint and LCA following ISO 14040/44). Furthermore, we have certified the quality, safety and low environmental impact and emissions of our products and production processes following the most strict certification programs and norms available.

For a complete picture of a material or products' environmental sustainability, all stages of its life cycle, from cradle to grave, must be considered. As will be explained below, MOSO bamboo products provide compelling advantages in sustainability during all phases of their life cycle. Please take note that because of MOSO's focus on sustainability, various improvements have been made over the years in the MOSO production chain to lower the environmental impact even more. Therefore the advantages over the life cycle as explained below only apply to bamboo products of MOSO International following best technology available, and do not apply to other bamboo suppliers.

In case you still have questions about the green credentials of MOSO bamboo products after reading this document, please contact us via sustainability@moso.eu for additional information.





MOSO during growth



Moso bamboo - fastest growing plant in the world

Bamboo is not a wood but a grass species. Although there are about 1500 different bamboo species, in terms of availability and ease of processing, there is only one giant bamboo species truly suitable for manufacturing high quality products such as panels, beams and flooring. This species, the “Phyllostachys Pubescens”, grows mainly in China, where it is known as “Maozhu” or “Moso” bamboo.

The giant bamboo species Moso belongs to the fastest growing plants in the world; it may reach its final length of up to 20 meters high within a couple of months (with a speed of up to 50 cm a day during the growing season!). As a result, the Moso bamboo plant absorbs a large amount of CO₂ out of the atmosphere - providing oxygen in return - and is widely available (in China around 7 million hectares in 2014). It takes the stem around 4-5 years to mature and acquire its excellent hardwood-like characteristics (hardness, strength, dimensional stability). This stands in sharp contrast to the growing time of hardwood species which often take over 50 years to mature, are increasingly scarce and often more expensive. In short: **Bamboo grows faster than softwood and combines this with hardwood properties.**

Interestingly, one bamboo plant consists of several poles and new shoots will grow from the mother plant every year. Generally 20-25% of the poles in a bamboo forest or plantation can be sustainably harvested each year without decreasing the size of the plantation or the number of poles per hectare. This means that the plant does not die after harvesting. On the contrary, by harvesting the mature poles, the yield and quality of the plantation actually increases. Thus, as bamboo - in contrast with hardwood - is best managed as an agricultural crop with an annual harvesting scheme, in practice, no deforestation takes place (see also below).

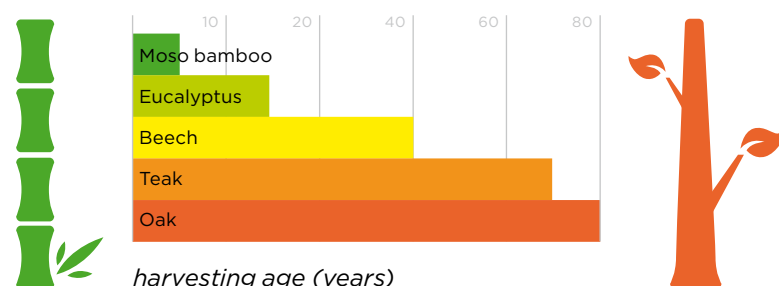
Sustainable Forestry

The bamboo reserves of Moso bamboo in China are significant (7 mio. ha) and following the market growth and recent landscape improvement programmes of the Central Chinese Government it is growing at a rate of around 5% annually (period 2010-2020). Interestingly, due to its extensive root network, bamboo reforestation is also possible on eroded slopes. This makes it a very suitable reforestation crop to restore vegetation and water tables on degraded lands (e.g. due to the clear-cutting of forests).

For its bamboo products MOSO derives its bamboo resources from the Zhejiang Province (Lishui and Anji County), Jiangxi Province (Fuzhou and Yintan County) and the Fujian Province (Nanping, Sanming and Longyan County).

It is evident that MOSO only sources bamboo material from sustainably managed forests and plantations. In essence, the Chinese Bamboo Forestry system which is controlled by the Forestry Bureau of China, already safeguards the sustainable exploitation of the existing bamboo resources. In this system that is based on periodic surveys of total bamboo coverage, a farmer is granted a “Forestry Logging Permit” for the responsible exploitation of a bamboo plot for a certain period. Each year the farmer harvests a part of the poles and sells them to processing industries (mainly strip producers who use the strips for specific products like flooring, panels, chopsticks and curtains etc.), thus utilizing 100% of the bamboo resource in final applications. In this sound functioning system it is in the interest of the farmer itself to work in a sustainable manner (no deforestation / clearcutting) to safeguard a constant income. As explained in the section above, this is also facilitated by the growth manner of the bamboo plant itself, where the annual clearing of the mature stems even stimulates the bamboo plant to regenerate even faster.

Since recently, bamboo is also available with FSC® certification, for more information see page 9.



MOSO in production



ISO certified facilities - and beyond

ISO certification

All MOSO products are made in production facilities that are ISO 9001 and ISO 14001 third party certified and therefore comply with the most stringent norms and procedures with respect to quality and business management (ISO 9001) as well as human health, safety and the environment (ISO 14001). MOSO however goes further than these respected standards. To secure the superior quality of MOSO products and guarantee environmentally sound practises, MOSO has its own quality control activities executed by the 15 skilled professionals at MOSO China, located near Shanghai (100% subsidiary of MOSO International BV).



Environmentally Friendly Production

Besides the requirements posed by ISO 14001, MOSO opts for an environmentally friendly approach to processing bamboo strips into flooring, veneer, beams, panels, decking and cladding. A large part of the energy required in the factories is derived from bio-energy: burning sawdust and bamboo leftovers. This certainly contributes to the fact that all MOSO's solid bamboo products are certified to be carbon neutral or better over their full life cycle (see also section LCA – carbon footprint). Furthermore, MOSO is always searching for process innovations to improve the factory efficiency and reduce its environmental footprint. For example, in MOSO's veneer factory DMVP sophisticated waste water treatments facilities were recently installed

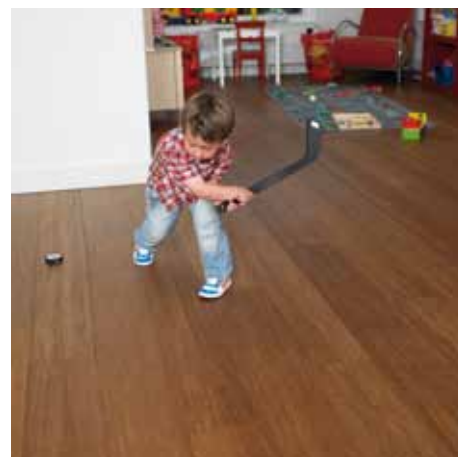
and waste management (recycling) procedures implemented. With respect to the adhesives and finishing materials used (e.g. lacquer, oil), MOSO exclusively cooperates with respected European suppliers that share our values with respect to sustainability and superior product performance: Bona & Treffert (lacquers), Woca (oils) and Dynea (adhesives).

As a result, quality is guaranteed and for example, all adhesives used by MOSO easily meet the E1 class following the EN 717 standard with respect to formaldehyde emissions and in several cases even meet the most stringent E0 class (see also next page).





MOSO in use



durable & healthy

Proven Durability

Durability is an important yet often overlooked aspect of sustainability. The longer the lifetime of a floor, decking board or panel, the lower the environmental impact will be in terms of replacement. With its hardness, density and dimensional stability similar or even better than the best quality tropical hardwoods, MOSO bamboo products can be applied effortlessly as a hardwood alternative in most applications. With respect to hardness, the MOSO high Density® version is even found to outperform the very best hardwood species, making it the best natural solution in heavy traffic situations.

Also for outdoors, MOSO offers the most durable solution with the decking & cladding product Bamboo X-treme. Through a patented, combined thermal modification and densification process, the weather and mould resistance of this outdoor product has been heavily improved.

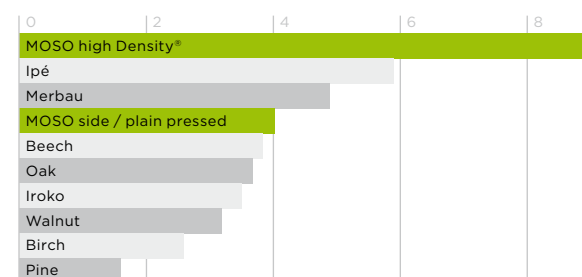
As a result, Bamboo X-treme has been officially assessed by the leading wood research institute SHR as durability class 1 according to EN 350, tested according to EN 113 and the even more stringent testing method ENV 807, which provides the resulting use class 4 according to EN 335.

Evidently, high durability can only be achieved by the best possible quality. Through our long experience in the bamboo industry (since 1997) we are confident that we provide the best product in the industry. We back this up by CE marking for our flooring in combination with an exceptional long product guarantee (up to 30 years!). Durability Guaranteed.



Brinell hardness

in kg/mm² according to EN1534



Healthy Indoor Environment

As a product from nature, MOSO bamboo flooring is the logical choice for a healthy indoor environment. In contrast to synthetic based flooring types such as carpets and laminates, MOSO floors are antistatic and anti-allergic. Furthermore, for the lamination of the bamboo strips we solely use adhesives that comply with the strictest European norms (currently the E1 norm), which are completely safe in terms of formaldehyde and Volatile Organic Compound (VOC) emissions. All MOSO products meet the E1 standard, while several MOSO products even comply with E0, the strictest (unofficial) emission class available, commonly used to indicate that the product has a very low or no detectable emission (formaldehyde emissions <0,025 mg/m³) and/or is produced with No Added Formaldehyde (NAF) glues. E0 products automatically qualify for the official E1 class. Furthermore, all MOSO bamboo floors have been rated A and A+ in France with respect to emissions of volatile organic compounds: the best classification possible!



MOSO in End-of-Life



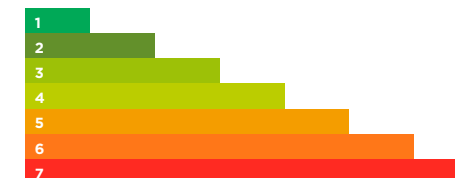
no restrictions in recycling

Recyclability

As a non-toxic, natural product, MOSO bamboo products offer no restrictions in the end-of-life phase. To encourage the best solutions in terms of value added and lowest environmental impact, we recommend users to adopt the “preferential sequence for waste management” issued by the Dutch government in the National Waste Management Plan (LAP - Landelijk Afvalbeheer Plan), also known as the “Lansink Ladder” to recycle our products. Actually, the popular Cradle to Cradle (C2C) philosophy to close biological and technological cycles as much as possible and re-use materials in applications with the same or even higher added value (up-cycling) is largely similar to the Lansink Ladder.

The model consists of the following possible waste management scenarios in which prevention is the most preferred option and dumping the least:

1. Prevention (avoid waste)
2. Prevention (design products that integrate waste avoidance and useful application during the end of life)
3. Useful application through product re-use
4. Useful application through material re-use
5. Useful application through energy production (incineration)
6. Remove: Burn
7. Remove: Dumping / Composting



As a result, in the design phase of projects in which MOSO bamboo products are implemented, where possible we recommend that consideration is given to the ease of disassembly so as to facilitate consequent reuse in similar applications (upcycling). In (most) cases where upcycling is not possible, we recommend that MOSO bamboo products are used as input in chipboards or for bio-energy production through incineration in a biomass energy plant, thus substituting the use of fossil fuels.

research & certification



Campus Palmas Altas
Sevilla, Spain
LEED PLATINUM



Alta Diagonal
Barcelona, Spain
LEED GOLD



Venco Campus
Eersel, the Netherlands
BREEAM Outstanding



LEED & BREEAM

The use of MOSO bamboo products can help achieve a higher certification level for LEED and BREEAM, the most important green building certification programs

available worldwide. The table below gives an overview for which credits application of MOSO bamboo products can provide a direct or indirect contribution to these

schemes. For more detailed information and background information (testing reports, certifications, etc) please contact us at sustainability@moso.eu

contribution MOSO products to LEED & BREEAM

LEED version 4 (2013 -)	contribution	flooring	beams, panels & veneer	outdoor (bamboo x-treme)
MR Credit 1 - Building life-cycle impact reduction	direct	yes (if solid)	yes	yes
MR Credit 2 - Building product disclosure and optimization - environmental product declarations	direct	yes (if solid)	yes	yes
MR Credit 3 - Building product disclosure and optimization - sourcing of raw materials	direct	yes (if requested with FSC®)	yes (if requested with FSC®)	yes (if requested with FSC®)
EQ Credit 2 - Low Emitting Materials	direct	yes	yes	
IN Credit 1 - Innovation	direct	yes (if used in innovative applications or if helps to meet twice the criteria limit)	yes (if used in innovative applications or if helps to meet twice the criteria limit)	yes (if used in innovative applications or if helps to meet twice the criteria limit)
EQ Credit 6 - Interior Lighting	indirect	yes (if natural colour)	yes (if natural colour)	
EQ Credit 9 - Acoustic performance	indirect		yes (optional)	
LEED version 2009	contribution	flooring	beams, panels & veneer	outdoor (bamboo x-treme)
MR Credit 6 - Rapidly Renewable Materials	direct	yes	yes	yes
MR Credit 7 - Certified Wood	direct	yes (if requested with FSC®)	yes (if requested with FSC®)	yes (if requested with FSC®)
IEQ Credit 4.3 - Low Emitting Materials: Flooring Systems	direct	yes		
IEQ Credit 4.4 - Low Emitting Materials - Composite Wood and Agrifiber Products	direct		yes (if requested with EO glue)	
ID Credit 1 - Innovation in Design	direct	yes (if helps to meet twice the criteria limit)	yes (if helps to meet twice the criteria limit)	yes (if helps to meet twice the criteria limit)
EQ Credit 8.1 - Daylight	indirect	yes (if natural colour)	yes (if natural colour)	
BREEAM International credit	contribution	flooring	beams, panels & veneer	outdoor (bamboo x-treme)
HEA 2 - Indoor Air Quality	direct	yes	yes	yes (if used indoors)
MAT 1 - Life Cycle Impacts	direct	yes (if solid)	yes	yes
MAT 3 - Responsible Sourcing of Materials	direct	yes (if requested with FSC®)	yes (if requested with FSC®)	yes (if requested with FSC®)
MAT 5 - Designing for Robustness	direct	yes (if high Density®)	yes (if high Density®)	yes
Innovation	direct	yes (if used in an innovative application)	yes (if used in an innovative application)	yes (if used in an innovative application)
MAN 5 - Life cycle cost and service life planning	indirect	yes (if high Density®)	yes (if high Density®)	yes
HEA 1 - Visual comfort	indirect	yes (if natural colour)	yes (if natural colour)	
HEA 5 - Acoustic performance	indirect		yes (optional)	

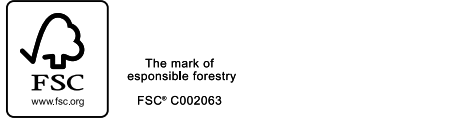
FSC® certification for bamboo

Although the bamboo forestry system in itself guarantees sustainable harvesting practices, the demand for third party certified forestry regimes has grown over the years. The most respected and generally accepted, sustainable forestry certification system is the FSC® label (www.fsc.org). FSC® stands for Forest Stewardship Council and is an independent, non-governmental organisation. Established in 1993 it promotes the responsible management of forests and plantations around the globe.

FSC® certification ensures that companies that work in the “chain of custody” (thus from harvesting to the final product) share and maintain FSC®’s core sustainability values – based on an adequate balance between People, Planet and Profit.

In 2004, FSC® allowed bamboo in their certification system. For bamboo however it has always been questionable if FSC® certification was really necessary: bamboo is not a wood, it is a grass with its own harvesting requirements. In producing bamboo products no deforestation is necessary or even possible, since only the 4-5 years old stems are harvested each year (if the stems are not mature they are useless for most applications). Nevertheless, to meet the growing demand for FSC® certified bamboo products, MOSO was one of the first bamboo suppliers to become FSC® certified (in 2008), as was MOSO’s daughter factory in bamboo veneer: DMVP.

To comply with the stringent FSC® Chain of Custody guidelines, the procedures and practices of the whole MOSO group is assessed annually by the independent certification body Control Union (www.controlunion.com).



research & certification



LCA & carbon footprint

Life Cycle Assessment (LCA) is the commonly accepted methodology to systematically assess the environmental impact of a product or material over its full life cycle, thus from the extraction of resources until the end phase of demolition or recycling (from cradle till grave). The LCA methodology is internationally standardized in the ISO 14040 series and measures the environmental impact in several categories, including depletion, air quality (dust, smog), toxicity and global warming potential (GWP). The environmental impact caused by a product can be measured in one number, for example expressed in eco-costs. Given the increasing attention regarding global warming, a product's GWP is often assessed separately in a so-called carbon footprint. In this assessment all the greenhouse gas emissions during the life cycle of a product are measured in kg CO₂ equivalent.

To gain a better understanding of the environmental impact of its products, MOSO has undertaken a long term strategic partnership with two leading research organizations in the field of LCA, carbon footprint and bamboo: Delft University of Technology (www.tudelft.nl) and the International Network for Bamboo and Rattan (www.inbar.int). This has resulted in several scientific publications (for more information see last page "references" page 12) including an official Life Cycle Assessment (including carbon footprint) following the ISO 14040 and 14044 standard.

The official LCA shows that bamboo is an important CO₂ 'fixator'. This means that bamboo absorbs a relatively large amount of CO₂ from the air / atmosphere (and releases a subsequently large amount of O₂ in return through the photosynthesis

process) during its growth and life until harvest. Since the area of permanent MOSO bamboo plantations is growing steadily (5% per year), an increasing amount of CO₂ is permanently locked in the plantations. After the harvest, this CO₂ will remain locked in the material and will only be released when the material is discarded or burnt in the end-of-life phase. Preferably in electrical power plants where it can substitute the use of carbon intensive fossil fuels and can thus be perceived as an additional carbon credit following LCA methodology.

On the other hand, CO₂ is released by the machines and transport methods needed to produce the bamboo products and deliver them to the customer. The CO₂ balance of a product over its full life cycle can be determined by comparing the CO₂ fixation during growth and fossil fuel

substitution in the end-of-life phase with the emissions during production, transport and use. When through CO₂ fixation and fossil fuel substitution the carbon credits are larger than the emissions, the product is CO₂ neutral.

The latest LCA report ¹⁾ (2014) concludes that all the assessed MOSO products (all solid bamboo flooring, beams, decking, cladding and panels) are CO₂ neutral or better over their full life cycle. This applies to the laminated strip product (Plybamboo - side / plain pressed), the compressed high Density[®] product (also known as Strand Woven Bamboo - SWB), both for indoor and outdoor use, and the Flattened bamboo (MOSO Bamboo Forest).

¹⁾ Available on request through: sustainability@moso.eu

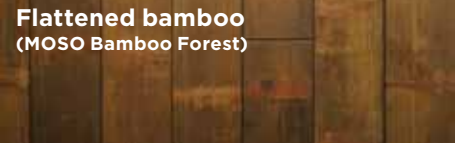
The report stipulates that the MOSO Bamboo Forest floor is even the most sustainable floor available in the market, for more information click [here](#).

The growing speed of renewable materials in terms of annual yield in m³/ha is not included in a LCA / carbon footprint and can therefore be perceived as an additional environmental advantage for renewable materials in general and in particular for the most rapidly growing resources such as Moso bamboo.

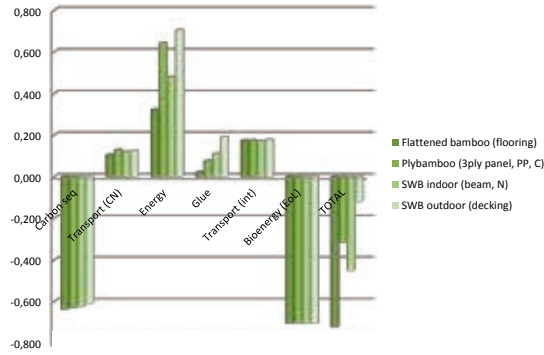
IMPORTANT: MOSO is the only bamboo supplier worldwide to have executed a full LCA following ISO standards. The LCA was performed for the specific case of the MOSO production chain following best practice and can therefore not be perceived as being typical for the production chain of other industrial bamboo material manufacturers. Therefore, if other manufacturers claim the same, one should always ask them to back up their claim by asking for a full report following ISO 14040/44.

Continuous development

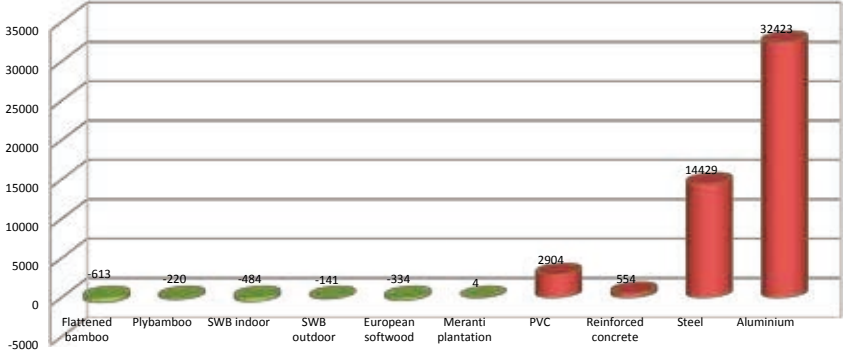
To MOSO it is very important to keep the greenhouse gas emissions as low as possible. As a result of the 2011 LCA and carbon footprint analysis, several improvements in the production process have been made resulting in a lower environmental impact in the 2014 assessment. Besides increasing efficiency in production and transport (higher volumes produced and transported for less energy and gasoline per unit), this relates to lowering the amount of resin in the products to as little as 1% for some products and increasing the percentage of completely formaldehyde free resins complying with the most stringent E0 norm. As a next step, MOSO is actively investigating the use of 100% biobased resins for several of its products.



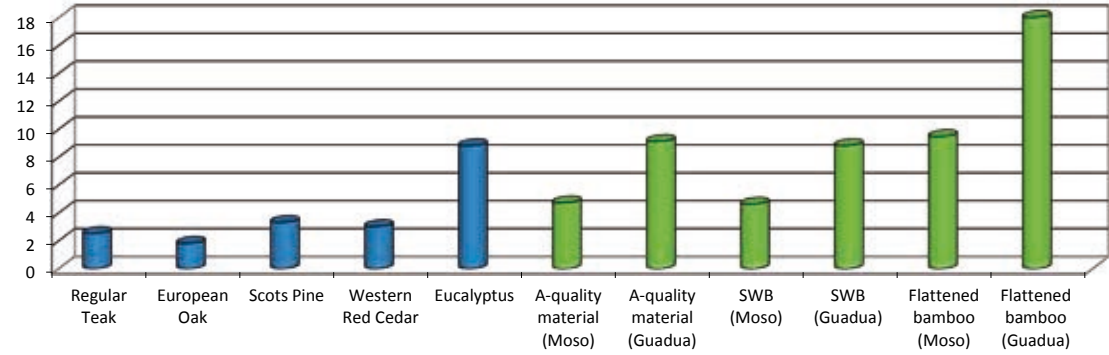
Carbon footprint over life cycle (kg CO₂eq / kg product)



Carbon footprint over life cycle (kg CO₂eq / m³)



annual yield (m³/ha/yr)



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