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PÖYRY POINT OF VIEW - NOVEMBER 2014

Reinventing plantation forestry

Moving off the Yield Plateau

Have the competitive advantages of plantation wood become extinct?

Annually, the world consumes some 1.7 billion cubic metres of wood for industrial applications - about a third of that, more than 450 million cubic meters, is sourced from fast-growing plantations.

THE ROLE OF PLANTATION FORESTS

Over the last four decades, wood sourced from fast-growing industrial plantations has gained a 27% market share over wood sourced from other natural and semi-natural forests. The key drivers behind the increasing importance of industrial plantations are:

- superior cost and quality competitiveness of fast-growing plantation forests
- migration of forest-based industries into emerging countries
- increasing environmental awareness reducing demand for wood sourced from natural mixed tropical forests

Fast-growing plantation production cycles in tropical and sub-tropical regions are typically shorter (5-12 years versus 20-60 years) and productivity is higher (30-50 m^3/ha/a versus 5-15 m^3/ha/a) than in natural / semi-natural forests in temperate and boreal regions. Furthermore, forestry operations can be mechanised and automated to a large degree. Additionally, wood quality is more homogeneous and tailored to modern large-scale industrial processes. These features provide both economic savings and quality improvements for the whole value chain - from land usage, via plantations and industry to final products.

There is no doubt as to the economic success of fast-growing plantation forests in the tropics [see Figure 1]. But the forces that once made plantation forests competitive are weakening and there are clear signals of a fundamental change that affects specifically the cost competitiveness of plantation forests.

KEY ELEMENTS OF PLANTATION WOOD COST

The three main forces changing the economics of plantation forests are:

- Forest productivity
- Cost of services and inputs
- Opportunity cost of land

FIGURE 1 - GLOBAL AREA OF FOREST PLANTATIONS

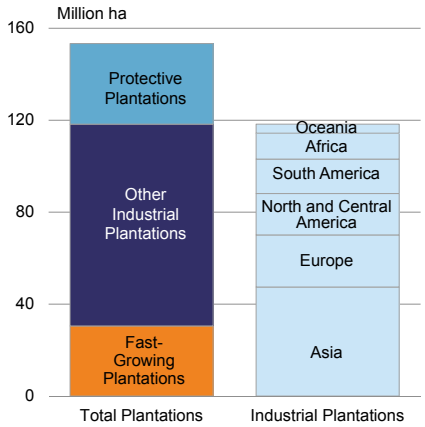
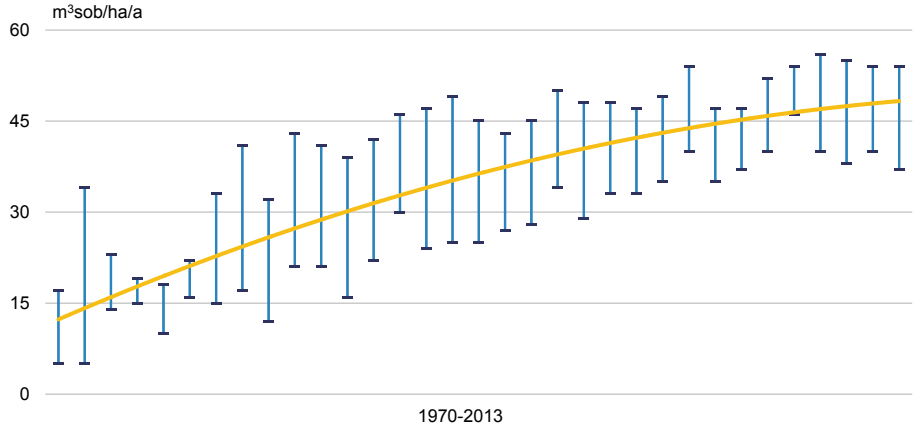


FIGURE 2 - DEVELOPMENT OF EUCALYPTUS PLANTATIONS PRODUCTIVITY IN BRAZIL



FOREST PRODUCTIVITY – REACHING YIELD PLATEAU?

There have been substantial advances in plantation forest productivity during the last 40 years [see Figure 2]: the best world averages of commercial plantation forest yields increased almost five fold, an annual growth of about 3.5%/a. However, despite higher yields having been a key source of competitive advantage, even the most optimistic estimates of yield increase foresee a decline in the growth rate of yield, perhaps down to 1.5%/a, half of what it used to be. Yield plateaus are also accompanied by yield declines in some regions, despite increasing investment in forestry technologies. This could indicate that maximum potential yields have been reached under the current models, management regimes and the impacts of climate change.

A similar phenomenon is being experienced with several of the world's major agricultural crops. Major gains provided by the "green revolution" have started to fade away. The deceleration of the relative growth rate of yields creates strong evidence that, with current technologies, we are reaching yield plateaus in plantation forestry. This needs to be offset by seeking new paradigms for higher yield growth such as promoting innovative bio-technology solutions, increasing the precision of forest operations and by gaining a better understanding of the eco-physiologic aspects of plantation forests (e.g. the efficiency in the use of water, light and nutrients). In other words, improved productivity will only be achieved by reinventing plantation forestry as a whole.

COST OF SERVICES

During the early days of plantation forestry (the 1960s and 1970s), in countries such as Brazil and Chile, there was a large commitment to forest innovation. This involved cooperation between several forest product companies, universities and research institutes and active state support. It led to the creation of the "new tropical forestry", including the introduction of the first commercial eucalyptus hybrid clones, intensified silvicultural practices and improvements in mechanised harvesting. A widespread atmosphere of innovation was followed by economic results. A similar attitude and commitment from industry leaders would be required today.

Reducing labour intensity via mechanisation is vital – labour costs are bound to increase above inflation in economies that are experiencing fundamental societal transformation such as China, Brazil, Indonesia, Vietnam and Uruguay – the emerging economies. No longer can plantation wood cost advantage rely only on cheap labour as a basis for competitiveness.

FIGURE 3 - WOODCHIP TRADE FLOWS INTO ASIA

SIMILAR CHALLENGES: ASIAN AND SOUTH AMERICAN PLANTATION FORESTRY

The rapid growth in demand for wood-based products in Asia, particularly in China, has triggered a sharp rise in the global trade of wood during recent years, in logs, lumber and woodchips [see Figure 3]. With an emergent middle class set to continue expanding exponentially in the coming decades, Asia's new consumers remain the largest market for wood and wood-based products. The wood fibre demand/supply balance in Asia Pacific is at an interesting point in its history. Tropical wood supply is in rapid decline with a shift to reliance on plantation grown wood.

Today more than 40% of the world's tree plantations are located in the Asia Pacific region. Key plantation growing countries include China, Indonesia, Thailand and Vietnam, in addition to Australia and New Zealand, which have the largest industrial plantation areas in the region. Large-scale plantation expansion in Asia is more challenging than in South America, given the population densities and short supply of available land. Therefore most of the efforts need to concentrate on improving the quality and yields of existing plantations. Plantations in Asia have shown much lower average yields than those in South America. Lower average yields in Asia can be explained by a multitude of factors – with wide variations within countries and regions.

In most countries in Asia plantation forest ownership is fragmented and in the hands of very small farmers with limited access to technology or capital. Indonesia is an exception with large company-owned plantations and joint-venture plantations to supply wood to world scale pulp mills. The Indonesian plantation industry is presently challenged by tropical tree diseases and rapidly rising labour wages, resulting in increasing delivered wood costs. This does not imply that Asia has less potential than South America – Pöyry has identified areas within Asia where both forest yield and delivered wood costs at mill can be competitive with the best plantations in Brazil or Chile.

Similar challenges in South America and Asia suggest that more interaction between companies, industries and institutions would benefit both sides. At Pöyry we have been able to connect our talented foresters in South America to our Asian clients, and vice versa.

Reaching operational excellence

Brazil, as well as many other emerging economies, has experienced major social improvements as the new consumer middle class continues to grow. This growth followed a rise in the general salary level. For example, a six-fold increase took place between the 1990s (when the minimum salary was close to 50 USD/month) and now (300 USD/month). Labour productivity has also improved, but at a much slower pace than salaries (from about 600 m^3/person/a in the 1990s to 1500 m^3/person/a today).

With regards to the development of plantation wood costs, in 1975 the plantation pulpwood cost in Brazil was about 50 USD/ton of pulp (real 2013 money) but by the early 2000s it had increased to 80 USD/ton of pulp. Today, the average eucalyptus wood cost delivered at mill would be more than 100 USD/ton of pulp. Labour cost represented only a fraction of the delivered full cost for wood at mill in the 1970s but today accounts for more than 40% [see Figure 4].

THE OPPORTUNITY COST OF LAND

The availability of land suitable for plantations is, in theory, abundant in many places in South America and Africa. However, the quality of this land varies remarkably. When screening for plantation land one should consider degraded agricultural areas, inclined terrains, low-yield pasture lands and agricultural frontiers.

However, location of commercial plantation forests needs to be relatively near the industries it is intended for – if wood needs to travel more than 250 km by road, it may decrease the competitiveness of an associated industrial plant significantly. Worldwide, there are several plantation areas today which are uncompetitive for industrial processing. This is because they are located in regions with poor infrastructure or limited availability of e.g. industrial water. The location of forest plantations in relation to the industry and consumer markets is a key success factor in the economics of plantation forests.

Suitable plantation forest land is also becoming expensive in many emerging economies as the competition for land intensifies. In countries where land is held and controlled by private investors, farmers and companies, land appreciation is driven by increasing demand for alternative uses –mainly agricultural purposes. In countries where land is controlled by Government, land concession costs (such as long-term leases) are also expected to appreciate for the same reasons. While farmers, plantation forest investors and agricultural companies attempt to reserve the rights to the best lands, governments and private owners are more aware of the political and economic value of this prized resource.

For example, in the early 2000s, one hectare of land adequate for forest plantation would be priced at about 500-1000 USD in Brazil. 60-70% of the acquired land could be used for commercial plantation. Land Capex for a 1 million ADt/a pulp mill would reach some 100-150 million USD.

Today, plantation forest land can be acquired at 1500-2500 USD/ha. The use of land as commercial plantations is smaller, as there are stricter environmental requirements or land is typically less flat. For a modern pulp mill, the total land Capex rose to 200-300 million USD today [see Table 1].

FIGURE 4 - DEVELOPMENT OF DELIVERED EUCALYPTUS CASH WOOD COSTS IN BRAZIL

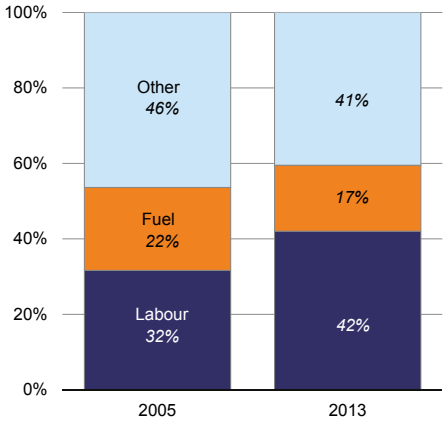


TABLE 1 - DEVELOPMENT OF LAND AND FOREST CAPEX FOR A MODERN SCALE BHKP PULP MILL

		Early 2000's	Today
Modern BHKP pulp mill size	million ADt/a	1.0	2.0
Land price range	USD/ha	500-1000	1500-2500
Total Capex in land	million USD	100-150	200-300
Forest yield expected	m^3sob/ha/a	35	45
Silvicultural Capex for a 6-7 year cycle	USD/ha	1000-1500	1700-2500

"The rising cost of labour is a catalyst for reinventing plantation forestry"

STRATEGIES AND TOOLS TO PROACTIVELY REINVENT PLANTATION FORESTRY

A new wave of innovation is needed. In order to further improve the competitive position of plantation wood, and the ability of plantation forest companies to differentiate from each other, there are two main areas to address.

EXCELLENCE IN OPERATIONS MANAGEMENT

Companies need to identify opportunities to improve forest management processes and practices. This concerns both plantation establishments and maintenance, wood harvesting and supply logistics. Key questions to be addressed include:

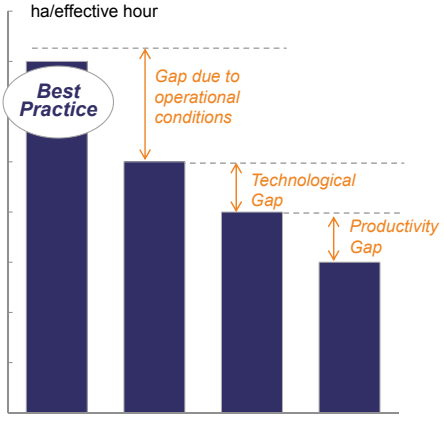
- what are the best practices used in the market and industry today?
- how large are the productivity gains, if improved and new models are adopted by the company?
- how much operating cost can be saved and what are the required investments to reach the anticipated benefits?
- how can the improvements be implemented in practice?

Having a solid diagnosis at hand is an essential tool to promote the reduction of delivered wood costs (without major Capex), to increase the productivity of operations by developing and adopting best practice, and to improve the alignment of wood qualities vis-à-vis industrial demands [see Figure 5].

DISRUPTIVE INNOVATIONS

Excellence in operations will bring cost savings without the burden of large investments. But a new paradigm of plantation forest will only be created by promoting the invention and adoption of disruptive technologies - completely new ways of producing plantation wood. Among leading companies in plantation forestry, some new technologies are beginning to appear - these require time and significant investments in applied sciences and R&D. Companies need to seek cooperation between specialised experts, equipment suppliers, research institutes and universities across a wide range of segments - a truly daunting task to bring the power of cross-disciplinary know-how to ultimately benefit plantation forestry and related industries.

FIGURE 5 - REACHING OPERATIONAL EXCELLENCE IN FORESTRY OPERATIONS



IDENTIFYING BEST PRACTISES FOR IMPROVED FORESTRY OPERATIONS - EXAMPLE

Acidic soils can limit the availability of some essential plant nutrients while increasing the relative concentration of toxic elements (such as aluminium). Soil acidity can be corrected by liming procedures, e.g. by adding limestone to neutralise the acid present. Liming can be very labour intensive, especially in hilly and mountainous areas as limestone needs to be applied mainly by hand, tree-by-tree. In a recent large-scale forestry operational excellence program Pöyry and its client identified concrete measures to improve the efficiency and reduce operation costs in a range of forestry operations, including liming.

By carefully analysing and benchmarking current operating practises within several plantation regions of the company, the work was able to diagnose the root cause of inefficiencies. Up to 45% inefficiencies in the use of working time in liming were identified. We recommended a set of working procedures to create the best practise in manual liming application, including standardisation of working methods, improved planning and focused labour training. Specific recommendations were given considering the distinct characteristics of topography and soil qualities in each of the regions analysed. By reducing the burden of unproductive working time the proposed measures promoted savings of up to 20% in operating costs, with minimal capital expenditure.

Disruptive innovations

ON-GOING EXAMPLES OF DISRUPTIVE INNOVATIONS

ADVANCES IN BIO-TECHNOLOGY

There have been several innovations in the field of genetics that pharmaceutical, chemical and agricultural sectors have adopted, with potential spin-off benefits for plantation forest business. Quantum leaps in genetics are being achieved as our ability to understand how changes in DNA affect phenotypes (observable characteristics such as fibre morphology, biochemical properties, etc).

Tailor-made trees are becoming a reality:

- Trees themselves will be "engineered" and highly specialised for a purpose. For example, by reducing the amount of lignin in wood, or by changing the composition and mix of the various components in lignin, pulp yields can be substantially improved.
- At the same time, if the target is to produce biomass for energy the opposite might be required: higher energy content in wood is typically associated with a higher share of lignin in wood.
- Traditional selective breeding methods combined with advanced genomics and improved silvicultural techniques are being used to introduce plantations into more challenging environments where e.g. the availability of water is limited.

In addition, the use of cellulosic derived sugars (so called 2G sugars) for the production of value added chemicals, bio-plastics and bio-fuels will rely on advanced genetics and digital selection tools.

MECHANISATION OF PLANTING AND RELATED OPERATIONS

About two-thirds of silvicultural costs in plantations incur in the first years of operations. Planting between 1,000 and 3,000 seedlings per hectare is typically a semi-mechanised operation, which is often labour intensive and time consuming. Currently less than 15% of the hours spent on plantation establishment comes from mechanised operations. On the other hand, most agricultural crops have fully mechanised operations and make use of unmanned robots and machinery to improve productivity. In this context, a consortium of leading Brazilian plantation companies was established in 2013 to tackle the issue of mechanisation of silviculture. They are cooperating with selected equipment suppliers, universities and institutes to develop a "multi-task machine" – the aim is to reduce plantation establishment costs by planning, designing and reshaping the whole production processes of the first two years from planting. This multi-task machine will eliminate labour intensive processes by combining several forest operations into one (e.g. planting, fertilising, weed & insect protection). Multi-task machines are also being developed for wood harvesting and transport operations.

UNMANNED AERIAL VEHICLES OR "DRONES"

For years, land surveys have been performed with small aeroplanes or helicopters. This is expensive and time consuming. The advent of unmanned aerial vehicles (UAV, or the so called "drones") equipped with sensors (like light detection and ranging (LIDAR) laser beams) has huge potential to reduce survey costs whilst improving accuracy and frequency of measurements. These are already extensively used in agriculture and are now reaching plantation forest companies. Each and every tree can be measured to within a centimetre of accuracy, resulting in substantial savings in forest inventory costs. Drones can also be used to detect and precisely map areas with pest damage or where competing vegetation is intense, providing the opportunity to reduce the usage and improve efficiency of pesticides and herbicides. The same technology can be used to detect forest fires quickly and precisely, providing real-time information to fire fighting teams. Leading companies are already adopting the use of drones equipped with several remote sensors to improve their forest management. The tools of the digital age are being applied in the forest industry.

RETHINKING PLANTATION FOREST OWNERSHIP STRATEGIES

In the mid-1970s, plantation forest owners in countries such as Chile or Brazil were mainly industrial players: pulp, panel and sawnwood companies. This was natural, as land was inexpensive and it was difficult to convince local farmers that planting trees could be a viable business enterprise. The thinking of farmers and industry has evolved – farmers and institutional investors understood that plantation forest can complement their agricultural income, whilst providing solid returns on their investment. In recent years, the industry has seen a significant increase in plantation ownership from independent producers – today they account for 35% or some 2.5 million hectares of commercial plantations forests in Brazil.

GROWING THE FOREST OF THE FUTURE TODAY

Plantation-grown wood will continue to gain market share over wood from natural or semi-natural forests. However, competitive advantage of plantations is narrowing and, in the worst case, will disappear unless the plantation growers put a major effort into productivity improvement and into identifying future cost saving opportunities. Rising costs in emerging economies, particularly the rising cost of labour, is a catalyst for reinventing plantation forests.

Trees, plantations and managers of the digital age will enhance the quality of living of millions of people – trees and other crops form the core element of an innovative bio-based economy.

Pöyry Management Consulting has a proven track record of on-the-field expertise combined with a deep understanding of the whole value chain of forest-based products. In recent years, our global teams of experts, from a wide variety of fields, have provided innovative solutions to plantation forest companies. Some of these assignments have been focused on improving forest management practices, i.e. in collecting the low-hanging fruits by promoting operational excellence. Others have been seeking for science-based solutions, while making sure that the cost/benefit of disruptive innovations can create value to forest owners and operators. We invent the forest of the future today!

"Trees of the future will be highly specialised, like dog breeds: designed to fit the owner's need."

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About the Pöyry Point of View

Staying on top of your game means keeping up with the latest thinking, trends and developments. We know that this can sometimes be tough as the pace of change continues...

At Pöyry, we encourage our global network of experts to actively contribute to the debate - generating fresh insight and challenging the status quo. The Pöyry Point of View is our practical, accessible and issues-based approach to sharing our latest thinking.

We invite you to take a look – please let us know your thoughts.

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