WOOD IN THE THIRD MILLENNIUM

BY W.R.J. (WINK) SUTTON

I have long had doubts about our ability to predict the future. Much of the future cannot be predicted because it is impossible to foretell millions of future events and actions. It is equally impossible to predict how these will all interact. Much of the future is simply unpredictable. I am increasingly convinced, however, that we can influence the future by our actions. To a large extent we (individually and collectively) *create* our own future.

To give my views on how we might create a wood future, and therefore a plantation forestry future, I am presenting my vision as if I were writing this in 2999 and giving a historical review looking back over the last 1,000 years.

Fast Forward to 2999...

Some of the matters I will discuss are now so well known and so well understood that I am reluctant to even mention them in this review. I include them for the sake of completeness. And just in case someone looks at this review after another 1,000 years!

Wood now dominates our use of materials so much that most people simply accept that this has always been so. However, at the start of this millennium (the year 2000), the harvesting of forests for wood was controversial. There was controversy over the practice of creating forests and intensively managing them for wood production. The controversy even extended to the practice of planting tree species that were not originally indigenous to the region. In contrast, agriculture had always accepted the practice of using the most desirable, the most convenient, the most productive, and the most manageable species (no matter where the species originally came from).

This review of the last 1,000 years (2000 to 2999) has forcefully reminded me of something we all learned at school, but which most of us have now forgotten, i.e., had it not been for drastic changes in the world in the first 50 years of the third millennium (2000 to 2050), the global population and civilization would probably not have survived. If by chance humans had survived without change, there would now be a smaller global population and they would certainly not be enjoying today's universal high standard of living.

Because of the importance of the years 2000 to 2050, this article will concentrate on understanding relevant events before and during that period. This is my interpretation of why drastic changes were necessary and how the change to a sustainable society was achieved. While it may not be initially apparent, this paper concentrates on those developments that are relevant to forestry and wood; I have largely ignored the exciting changes in other areas.

This is a 1999 photograph of 25-year-old radiata pine growing at Tikitere, Rotorua, New Zealand. Although some plantations now have greater growth rates, the growth at Tikitere was impressive, especially as the stand was pruned and grown for high quality sawlogs. Stocking was 400 stems per hectare with a mean diameter of 50 cm and a total volume of 940 m^3 per hectare (at age 25).

A "History" Lesson

Let's begin by understanding the world at the end of the second millennium (1999). The last century of that millennium (the 20th century) experienced a growth in population that the world had never known. The global population from year 1 to the year 2000 is shown in Figure 1. The population exploded from under 2 billion in 1900 to over 6 billion in the year 2000. Not surprisingly, many then were concerned by this increase. At least one country, China, was so concerned that in the latter part of the 20th century, the Chinese government introduced very rigid population controls: one child per woman.

In the 20th century, the growth in population was not uniform. Fertility rates (the average number of

children per woman) varied from a low of just over 1 in some countries to a high of over 7 in others. A static population has a (replacement) fertility rate of 2.1. With the exception of China (which at the beginning of the third millennium was still a relatively poor country) almost all countries with fertility rates below the level of replacement were wealthy and enjoyed a high standard of living. These were known as the developed economies.

The countries with high fertility rates were those countries that usually had low average incomes and correspondingly poor standards of living. These were known as the developing economies.

Figure 2 shows the population distribution (by age and sex) for the year 2000 for both the developed and the developing economies.

In 2000, 20 percent of the world's population lived in the wealthier economies and 80 percent lived in the poorer economies. If we look at the population of those under 5 years old, we see a statistic that must have alarmed many at the time: 11 percent lived in wealthier countries, while nearly 89 percent lived in the poorer countries.

By the end of the second millennium it must have been obvious that the growth in global population must be slowed. To not limit population growth would result in increased conflicts over land, water, resources, etc. World order would increasingly be threatened by wars, refugees, international terrorism, outbreaks of disease, etc.

Realizing the need to limit global population growth was easy, the difficulty was how to achieve this in a democratic way.

It was a complicating factor that the countries with the high fertility rates were almost always the poorer countries. Most poor countries were either indifferent to the problem, or, as seems much more likely, unable to enact any solutions that were politically or socially acceptable. China was only able to achieve a low fertility rate because at the time the country was under an authoritarian (and undemocratic) government.

Without any force or regulation, the wealthy countries had achieved average fertility rates less than replacement. The problem was how to get most of the world's poor to willingly limit their fertility rate.

A further complication was that the wealthy economies were not without their own problems. They did not have the problem of population growth but at the beginning of this millennium the wealthy countries had levels of consumption that were a major concern. Because the economic system then used in the world greatly discounted the future, it encouraged consumption.

An increasingly influential environmental movement (the greens) continually questioned the high levels of consumption in the wealthier countries. The greens had major concerns about the consumption of all resources, as well as pollution. The greens were especially worried about the use of fossil fuels, because they were non-renewable and because the increase in atmospheric carbon dioxide was expected to result in global warming with serious consequences (we all now know the realities of those concerns).

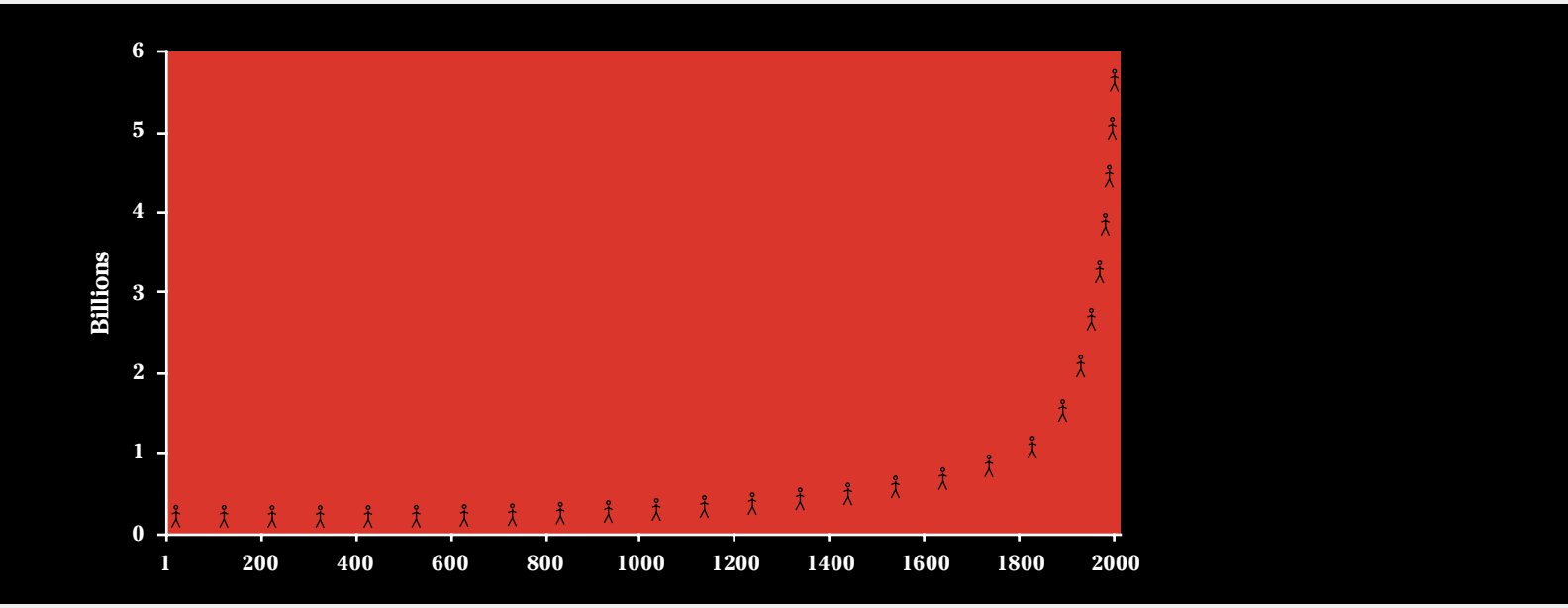


Figure 1. Global population from year 1 to year 2000.

The greens were worried about the loss of forests and the use of minerals. There were major concerns about the pollution of water and atmosphere that resulted from the use of resources.

The greens advocated reduced consumption (and actions such as re-use, recycling, and increased energy efficiency). However, although there were attempts, especially with recycling and energy efficiency, these did little to reduce total consumption. Most people were reluctant to give up their lifestyle for the long-term good of society.

Governments proved incapable of providing a solution. Reducing consumption is fine in theory but extremely difficult to achieve in practice. Plus, the aspect that was often overlooked was that consumption was both an essential driver of the economy and a major creator of employment. The greater the consumption the more people who can be employed. The more efficient they were, the more they could be paid. To reduce consumption means fewer jobs. Lowering efficiency reduces wages. If there was less employment and/or if wages were lower, then not only did governments collect less tax but demands on that government increased (for welfare payments, etc.). In some countries, green politicians were elected to positions of power. When in opposition, they were critical of the high levels of consumption, but when in power they were usually just as incapable of reducing consumption as any other government.

At the beginning of this millennium, governments were becoming less effective. As the markets of the world became more global and as people and industries could relocate with ease, governments found it increasingly difficult to maintain taxation regimes that differed significantly from other countries. This, and increasing pressures on governments to provide social services (health, welfare, etc.), meant that governments had little to invest in activities that could be done by the private sector, e.g., forest management.

Governments were also becoming increasingly ineffective internationally. Many would sign legally binding International Agreements, however, as was shown time and time again, countries could break these commitments (with what appeared to them justifiable reasons) and there was rarely anything other countries could do about the breech. This soon reduced the effectiveness of all International Agreements, but one. The one agreement which remained internationally enforceable was the commitment to free trade.

At the beginning of the millennium it was becoming obvious that the existing situation was not only unsustainable but also inequitable. The wealthy 20 percent of the world's population consumed approximately 80 percent of the resources being used.

It is difficult now to determine the exact order of events, but I shall attempt to give my understanding of what happened and why.

The theory behind the eventual solution was very simple: increase the average wealth of those in the poorer countries. The logic was that wealthy parents have fewer children. The problem was how to achieve a continuing increase in the average wealth.

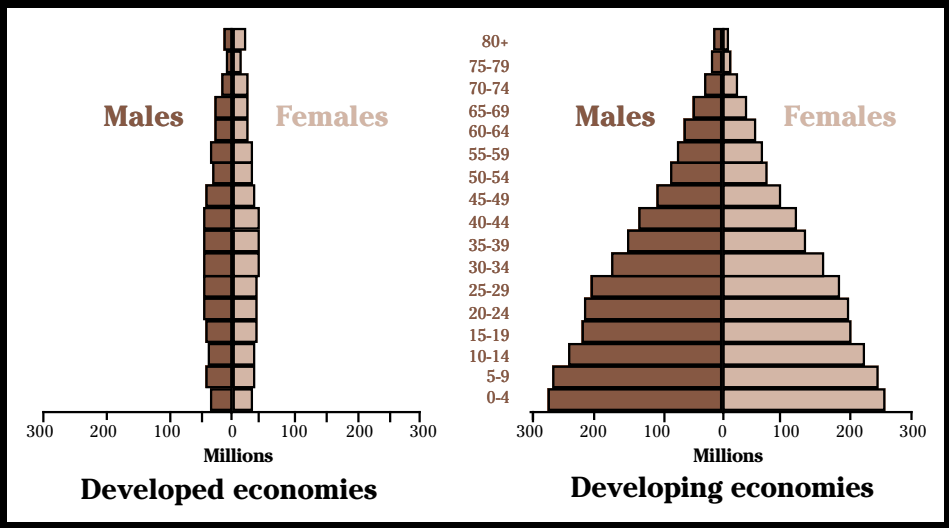


Figure 2. Distribution of year 2000 population by sex, age and economy.

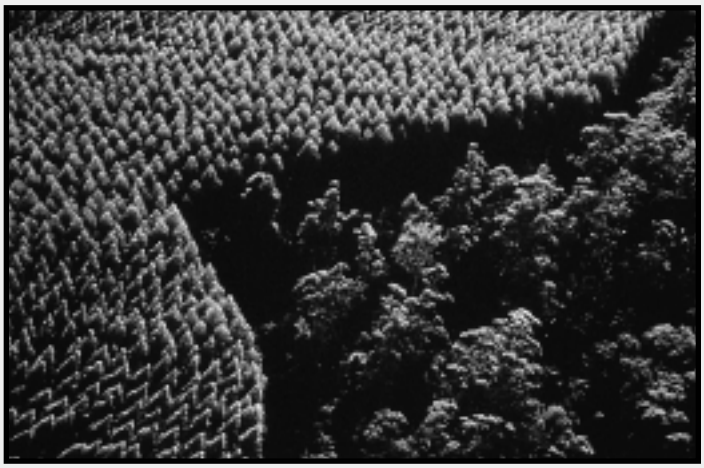
Much of the credit for the solution must go to the Chinese economist and strategist, Lu Ma. Her solution, first proposed in 2003, was for major loans from the wealthier countries. These loans were fundamentally different from the international loans that had become a feature of the latter half of the 20th century – loans that generally went to big projects that rarely increased public wealth, and some projects had corrupt management.

The prime objective of the Lu Ma loans was to greatly increase local entrepreneurship. The loans had four major conditions:

1. the elimination of bureaucratic controls and restrictions;
2. universal education with an emphasis on entrepreneurship;
3. the elimination of corruption;
4. a significant reduction in criminal activity.

By greatly stimulating local economies, the Lu Ma loans provided the poor countries with the opportunity to break out of their poverty. Globally, the loans had an effect similar to the Marshall Plan, which helped restart Europe after the Second World War of the early 1940s. The improvement in average living standards was faster than many thought possible.

Lu Ma is now regarded as one of the world's great economists, comparable to the likes of Adam Smith, David Ricardo, and John Maynard Keynes. The Lu Ma scheme solved the problem of global population; since 2100 the global population has averaged 10.5 billion (with a range of 9.9 to 11.0 billion). However, from the very beginning of the scheme it was recognized that the solution would create another huge challenge. Wealthy people enjoying a high standard of living are consumers. The average global population has been at a level that is 75 percent higher than that of the year 2000 and all are enjoying a high standard of living. This population, however, resulted in a massive increase in consumption: an almost sevenfold increase in total consumption over year 2000 levels.



This bird's eye view of a high-yielding pulpwood plantation at Aracruz, Brazil, shows that even in 1999 there were responsible forest managers who had started setting aside reserves of natural vegetation within plantations. (Photo courtesy of Aracruz Celulose S.A.)

This massive increase in global consumption was anticipated, and attention was focused on the supply of energy. Energy is basic to all consumption. Energy is required to first make and then to transport almost every product. A high standard of living is only possible if there is ready access to energy.

At the end of the last millennium, oil was not only a major energy source but its price was a distorting factor. In real terms, the price of oil was low. The global market was then awash with oil. The low oil price gave the misleading impression that there were few concerns about future supply. The result was a reduction in the effort to find energy alternatives.

Let us review the supply of energy up to the end of the second millennium. Prior to the first Industrial Revolution (which began in the 18th century), almost all energy used by humans came either directly or indirectly from the sun, e.g., food, wood, wind, and water. The first Industrial Revolution was largely based on the use of fossil fuels (coal, oil, and gas). Some energy still came from the sun: wood and electricity (from hydro dams, wind turbines, and photovoltaic cells).

In the latter half of the 20th century, some energy also came from nuclear power stations. All of that energy came from nuclear fission (the controlled breakdown of the unstable atomic nucleus of U^{235} with the subsequent release of energy; this energy was used to heat water to generate electricity). By the end of the second millennium, about 5 percent of the world's energy came from nuclear fission. Although most nuclear power plants could be regarded as safe, the public was generally suspicious. This fear was not helped by the 1986 partial meltdown of a Chernobyl nuclear power station (in what was then the USSR). That catastrophe resulted in the loss of human lives, the exposure of millions of people and animals to atomic radiation, and the pollution of land, water, and vegetation. The public concern was not only limited to power plants but also to the waste products of the nuclear fission process. We should now be very grateful that those nuclear fission power plants did not last beyond the early part of the 21st century. Their disappearance meant that we were not left with the problem of deal-

ing with a 1,000 years of accumulated radioactive waste from nuclear fission power plants.

The only other energy considered at the end of the second millennium was geothermal energy, but even after 1,000 years, geothermal is still only a very minor source of the world's energy.

The global dilemma was how to deal with a significant increase in world consumption (especially of energy) while using far less fossil fuel (and eventually none at all) and no nuclear fission energy. The solution to the dilemma came from what, at the start of the millennium, were surprise developments. There were two parallel developments that appear to have occurred independently but at approximately the same time.

The first development was within the environmental movement. The green movement was begun in the 1970s by those with a genuine concern for the environment. By the end of the 20th century, the movement had grown and become diverse. Many greens then appear to have been motivated by other concerns, e.g., the defeat of capitalism, free trade, and globalization. Many greens had become career activists. There was a growth in government agencies responsible for the environment.

There was a split in the green movement because of the challenge of finding realistic and lasting solutions. Those greens really wanting solutions rationalized that:

1. To be effective, solutions were most unlikely to come from either more regulation or increased conflict.
2. To reduce overall consumption was too simplistic for it could create more problems than it solved.

Those greens, although firmly committed to the environment, reasoned that lasting solutions must be supported by industry and be based on market forces. Those greens became known as the "blue greens."

Those greens who remained activists and/or committed to simplistic solutions such as regulation and reduced consumption became known as the "red greens."

The second development was within industry. Industry generally had the image of being only interested in profit and the short term. Industry at the start of the third millennium tended to greatly discount the future. Companies may have wanted to do things that were best for the long term, but they then faced difficulties surviving in a competitive market. Public companies that did take a long-term view were sometimes taken over by asset strippers who quickly converted the company assets into short-term financial gain. Within industry (and helped by some wealthy individual industrialists who had made huge fortunes) there emerged a realization that drastic action was needed and needed quickly. A cynic might claim that their main motivation was the realization that if global consumption increased three- to fourfold, that represented a huge global marketing opportunity. While this may have been part of their motivation, there is also no doubt that many industry people had very genuine concerns. This solution-oriented group became the "industrial greens."

Although forest fungi in plantations are now a major forest product (producing over a million tonnes per year of at least 46 mushroom types and 9 truffles), this was a relatively rare practice 1,000 years ago. An exception was this 1990s photograph of fungi collection from a radiata pine plantation in Chile.

The key to solutions came when the blue greens and the industrial greens both recognized that the problem was not consumption *per se*, but **unsustainable consumption**. There was no limit to consumption provided that it was **sustainable consumption**. From the beginning of the third millennium, the test of sustainability was applied to **all** consumption.

Because energy was the major factor in consumption, the search for sustainable energy became the main focus. Looking specifically at the world's main energy source - the fossil fuels - it was obvious that these were unsustainable. The world had to very quickly find not only sustainable energy alternatives, but these alternatives must be capable of supporting an energy demand that would eventually be many times greater than the total demand at the start of the third millennium. As we all now know, the two most successful sustainable energy sources were nuclear fusion and solar.

Nuclear fusion energy comes from the controlled fusion of heavy hydrogen (deuterium) into helium. Compared with nuclear fission, a huge advantage of nuclear fusion is the total absence of any radioactive waste.

Research on nuclear fusion had started 50 years before the end of the second millennium but research efforts had slowed because of poor public funding and because the industrial sector (with its very short-term focus) did not at first fully appreciate the potential of the technology. The public was largely unaware of the potential and many had great fear of all nuclear energy. At the start of the third millennium, there was little public understanding of the difference between the nuclear fission and nuclear fusion processes (the similarity of the two words did not help). Considerable effort (especially by the blue greens) was devoted to advocating the need for, and the advantages of, nuclear fusion energy. Nuclear fusion energy was finally accepted by the public because there was no other solution that could provide sustainable energy on the huge scale required. Today we refer to "nuclear fusion energy" simply as "nuclear energy." People today have a hard time believing that nuclear energy was once controversial.

But nuclear fusion energy proved to be more expensive than oil. In equivalent real terms, nuclear energy (which now directly or indirectly provides most of our energy) is at least three times as expensive to the consumer as oil was at the beginning of this millennium. There are many excellent accounts of how we convert nuclear energy efficiently into forms that not only power our ground, air, and interplanetary transport vehicles but also provide energy for processing and manufacturing. Because of the cost, and because it is only available in the form of heat, nuclear energy has never been the total energy provider.

The other major energy source is the sun. As those at the beginning of this millennium predicted, we still get some of our electrical energy from both hydroelectric power stations and wind turbines. It was once thought that the major use of solar energy would be from electricity from huge areas of photovoltaic (solar) panels. But only a few large collection areas were established. This energy source was always going to be limited to those areas with long sunshine hours and even in those areas, the energy costs have remained high and there is always the problem of the supply being only available for a maximum average of 12 hours of a 24-hour day.

Although at the beginning of the third millennium it was not standard, all buildings are now well insulated and incorporate large solar panels for air-conditioning and heating (including water heating).

The greatest contribution of solar energy is through photosynthesis. Photosynthesis provides almost all of our food. Some annual crops also produce energy products, e.g., rape seed oil as a sustainable substitute for diesel made from fossil fuel oil.

Photosynthesis makes its greatest contribution to our sustainable society through trees and wood. Wood provides energy-efficient products as well as most of our chemicals. A millennium ago, industrial wood was not even maintaining its position in the market. There were many then who expected that wood markets would be increasingly lost to substitutes such as metals, concrete, and plastics. With the advantage of hindsight we can now understand why there was a great improvement in the wood market in the third millennium.

PHOTOSYNTHESIS MAKES ITS GREATEST CONTRIBUTION TO OUR SUSTAINABLE SOCIETY THROUGH TREES AND WOOD.

The increase in wood use resulted from the change in the supply, and especially the cost, of energy. When it was cheap, convenient, and the supply apparently unlimited, energy was not a consideration. When the costs increased and there were increasing concerns about the pollution, the non-renewability, and the unsustainability of fossil fuels, the interest in wood increased.

Initially, wood was desirable because of its sustainability and renewability. However, the major additional contribution of wood comes from its energy efficiency. By the end of the second millennium, there had been several studies that had shown that wood was 10 times or even 20 times more energy efficient than wood substitutes such as metals or concrete. But initially, few appreciated that the energy efficiency of solid wood would ultimately prove to be much more important than energy that could be produced by the burning of wood. Recognition of this major advantage resulted in a huge effort to promote the use of solid wood in as many applications as possible. The result was significantly less wood used as a fuel. Although, as we shall see shortly, most wood eventually ends up as a fuel, only 5 percent of the total world wood harvest is currently used initially as a fuel. It may be hard to believe now,

but at the end of the second millennium, more wood was used directly as fuelwood than for all the industrial wood uses combined! We now know it makes more sense to manufacture energy-efficient solid wood products than to convert solid wood directly into energy.

Most wood is used as solid wood. The increased price for energy posed problems for energy-consuming reconstituted wood products such as particleboard, MDF, fiberboard, etc. These products still exist, but they have problems being price competitive with solid wood or re-engineered solid wood products. A significant pulp and paper industry still exists, but it is proportionally not the great wood consumer that it was 1,000 years ago. Packaging is still a major paper use but electronics eventually reduced the demand for printing and writing paper.

It was hardly recognized as a wood use at the beginning of the millennium, but the ligno-chemical industry soon emerged as the second most important wood use after solid wood. Since most fossil fuels were used for energy production, the initial efforts were to find a sustainable energy alternative. Nuclear fusion energy solved that need. But another important use for fossil fuels was for chemical production in the petrochemical industry. With the phasing out of fossil fuels, there was an urgent need for an environmentally friendly and sustainable chemical raw material. Nuclear energy supplied heat (and this could easily be converted into electricity and hydrogen) but heat is not efficiently converted into complex chemicals. Wood became the raw material for the large ligno-chemical industry. That industry now produces most of the world's complex chemicals, including those that once came from the petrochemical industry.

IT WAS HARDLY RECOGNIZED AS A WOOD USE AT THE BEGINNING OF THE MILLENNIUM, BUT THE LIGNO-CHEMICAL INDUSTRY SOON EMERGED AS THE SECOND MOST IMPORTANT WOOD USE AFTER SOLID WOOD.

The energy efficiency and usefulness of wood comes as no surprise. Photosynthesis first converts solar energy into sugar. The tree then converts that sugar into a host of complex chemicals (cellulose, lignin, etc. – at least 1,000 in all) and then combines them into a cellular structure that has high strength for its weight. It is that strength that gives the tree the ability to withstand the forces of nature. It is not surprising that wood is so energy efficient and so versatile. Its very complex chemical makeup means that wood is an ideal raw material for the ligno-chemical industry.

To illustrate the contribution of wood, let's trace the history of a typical plantation and its wood products.

A typical wood plantation contains plants with varietal material that, as in agriculture, have been so greatly modified that they are now very different from the natural species from which they once came. Most tree genotypes are now highly differentiated to meet the specific quality requirements for solid wood or wood chemical markets.

Stands are tended as appropriate for the wood qualities desired. Because solid wood is now the dominant wood end-use, timely and appropriate silviculture (thinning and sometimes pruning) is important. This is because tree quality (diameter, straightness, branch size, etc.) and wood properties (density, spiral grain, etc.) have remained important.

Stands are generally clearfelled at between 15 and 40 years and most are converted to solid wood. Conversion in processing is between 70 and 85 percent. Although the manufacture of solid wood products may involve edge, end, and face gluing, the objective is to keep wood in the largest pieces possible to minimize energy use. Residues (bark, chips, shavings, etc.) go mostly to the ligno-chemical industry. Some residues go to pulpmills and a small proportion goes to wood reconstitution plants. Very little wood (either solid wood or residues) is used directly as fuelwood.

Where the solid wood is to be used in hazardous conditions, the wood is treated with organic preservatives and/or fire retardants (which are both made from chemicals that came from wood). Some solid wood uses are in combination with plastics (again, wood is the origin of the chemicals for the plastic manufacture). Solid wood is now used for over 100,000 different products. Wood is the most versatile raw material the world has ever known.

Solid wood products generally have a useful life of 100 to 200 years. When no longer required, solid wood is sometimes burned, but usually is processed by the ligno-chemical industry. Used wood is converted into chemicals. These chemicals make our plastics, our artificial fibers, and thousands of other chemical products. At the end of their useful life, almost all of these chemical products are either recycled to make new chemicals or burned and the heat is utilized (district heating, power generation, manufacturing, etc.).

The wood industry is now a wonderful example of recycling. Most of the embodied solar energy in wood is eventually released and utilized, but not before the world has had an average of two centuries of solid wood and wood chemical use.

For wood to have been used on the scale that it has, there had to be some major changes. The biggest change was the acceptance of very large areas of plantations. At the beginning of the third millennium, there was strong opposition (especially from the red greens of the northern hemisphere) to anything that could be regarded as a tree plantation. Plantations were generally portrayed as being unnatural, as being an unsatisfactory land use, as being unhealthy, as prone to far greater risks than natural forests, etc. We owe much to the blue greens who, together with the industrial greens, played a major role in changing public opinion.

The blue greens and the industrial greens reasoned that wood was the world's most environmentally friendly raw material. Wood was sustainable, renewable, and energy efficient. Because of this, they also reasoned that wherever possible, wood should be advocated to replace steel and concrete. But where could the world find any more wood? Most agreed that it could not come from an increased harvest in the remaining natural forests of the world. There was general agreement that some of these forests should either be left completely alone or managed with only a minimum of wood extraction.

The solution was to do what agriculture had done for the last 10 millenniums: grow wood as a crop in the same way we grow wheat or maize. The blue greens did a masterful job in winning public acceptance in the advanced economies of the need for far more plantations. The poorer economies usually accepted the need for plantations. However, there were some countries that tried to restrict plantations, based on the argument that trees used water. Those countries eventually came to appreciate that plantations were at least as efficient water users as agriculture.

When it was first realized that a huge area of plantations would be required, the shortage of capital for plantation investment was perceived as a major problem. It was estimated that several trillion U.S. dollars of direct investment would be required. However, it was soon recognized that plantations were an ideal investment for retirement funds. For these past 1,000 years, investments in plantations have been a significant proportion of people's savings. The returns on plantation investments have been both reliable and competitive.

Plantation forestry has brought many social benefits. As well as professional managers, plantation forests require forest workers. These workers require skills, but often they can acquire those skills with only minimal levels of initial education. Forestry has greatly contributed to regional development as it is a productive and meaningful way of employing less-educated people who live in the more remote areas of the world.

Snapshot of 2999

The global population has been stable at 10.5 billion for over 900 years. Almost all the population enjoys a high standard of living. All can travel freely (but we pay about three times as much for our energy) and everything is much more efficient than it was 1,000 years ago. Almost everything we consume is renewable and sustainable. We waste nothing.

The world eats well, but compared with many of the wealthy countries of 1,000 years ago, we do not waste food, we consume less meat, and we have fewer pets. We feed 75 percent more people than we did 1,000 years ago, and we use less land per unit of food production because farming is now more productive. A huge area of land was released when farmers changed to tractors from draft animals (there were over 400 million draft animals a millennium ago, now there are less than 10,000).

There has been a huge increase in the area of tree plantations. Natural forests remain and most are now protected or in reserves. Most of the forests that would once have been considered managed natural forests are now essentially plantations managed for wood production.

Not surprisingly, the world is a great consumer of wood. Each of our 10.5 billion people consumes an average of 2.65 m^3 of wood per person per year. The average person in the world now consumes about four and a half times as much wood as they would have used at the beginning of the third millennium. On average, they now use 15 percent more wood per person than the average American did 1,000 years ago (the U.S. then had the highest per-capita wood consumption in the world). The total annual wood harvest is now just under 28 billion m^3. All but 1 billion m^3 of which comes from tree plantation crops

When people are poor, animals are commonly used for hauling (as in this 1980s photograph of oxen being used in a Chilean plantation). The greatly increased standard of living and availability of hydrogen (from nuclear energy) has resulted in almost total disappearance of beasts of burden. Almost all of the released 260 million hectares were converted to plantations.

grown to maximize the return on investment. The average productivity of plantations is just under 20 m^3 per hectare per year and plantations cover an area of 1.4 billion hectares – just under 10 percent of the earth's land area and equal to the combined areas of the former states of Brazil, Argentina, Peru, and Chile.

There are also 2.6 billion hectares of protected natural forests. A thousand years ago, the perception was that natural forests could be left unmanaged and untouched. However, experiences in many forests showed that biological diversity and forest health were significantly improved by responsible management. Limited and sustainable wood harvesting (totaling an average of 1 billion m^3 per year) is permitted in some of these forests, in part to offset the costs of forest management.

Forests (natural and plantations) now cover 4.0 billion hectares of land – 28 percent of the earth's surface.

The global economy and society are now stable and sustainable. We waste little. We use virtually no fossil fuels and almost all of our energy comes from either nuclear fusion power, or the sun. The major role of wood is not the provision of energy but the provision of energy-efficient material. Many of our buildings and many other products are now made from wood. Wood now supports a large ligno-chemical industry that provides most of our chemicals. At the end of its useful life, the embodied energy of wood is released by burning.

The world today owes its existence to the blue greens and the industrial greens of the 21st century. Their vision gave us a viable, realistic, and a sustainable solution to the twin problems of the population explosion and unsustainable consumption. Had they not found a solution when they did, and had they not strenuously worked for its introduction, then there is no way I could be writing this article in 2999 and there is no way you could be reading it!

Plantation forestry and wood were necessary for the survival of our civilization. Plantation forestry and wood are essential for our future.

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