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COMMON FUND FOR COMMODITIES

PROCEEDINGS OF THE SYMPOSIUM ON NATURAL FIBRES

Rome 20 October 2008



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Foreword

The General Assembly of the United Nations declared the year 2009 to be the International Year of Natural Fibres. The central objective of the year can be seen as promoting the use of natural fibres in current and novel applications, thereby contributing to increased levels of income for fibre producers, processors and traders, while at the same time contributing to the increased use of environment friendly materials in those applications.

There is a diverse range of natural fibres, of both plant and animal origin, produced by farmers throughout the world. Total annual production is around 30 million tonnes, three quarters of which is cotton. Most countries produce some natural fibres. In some cases, such as cotton production in Burkina Faso, natural fibres are of major importance to the national economy. In other cases these fibres are of less significance at the national level but are of major local importance within a country, as in the case of alpaca fibre in the Andes and sisal in north-east Brazil. Proceeds from the sale and export of natural fibres often contribute significantly to the income and food security of poor farmers and processors in the least developed countries.

Consumers use natural fibres in a variety of ways. The biggest outlet is apparel, but other uses such as home furnishings and carpets are also significant. Some fibres have more industrial applications, traditionally in cordage and packaging, but increasingly more in a range of non-traditional uses such as pulp for paper and in composite materials. In most of these applications natural fibres are subject to competition from synthetic substitutes. The Common Fund for Commodities sees it as one of its tasks to provide assistance to commodity producers to enable them to strengthen the quality of their production systems and to develop new products which will enable them to effectively compete with these synthetic products.

The Common Fund is therefore pleased to have been able to assist FAO in organizing this Symposium, as one of the start-up events of the International Year of Natural Fibres in 2009. In helping to raise the profile of natural fibres, we are contributing, on the one hand, to the livelihoods of the farmers who produce them, and on the other, to the use of an environmentally-sound, sustainable product.

This Symposium brought together people from many of the natural fibre industries to share views on the economic and technical issues facing these fibres. While each of these fibres is unique, they nevertheless have much in common. All, being natural products, are sustainable and healthful products, but all are in competition with synthetic materials. To varying degrees, technological progress has facilitated efficiencies in production and improvements in product quality to better meet the needs of consumers, and thus has allowed these fibres to continue to compete with synthetic fibres. Ongoing technical progress will be needed to enhance the viability of these fibres in the future.

I do hope that the papers presented here provide a useful guide to the place of natural fibres in today's world, and to the path they may face in the future.



Amb. Ali Mchumo
Managing Director
Common Fund for Commodities

Overview of the Symposium

The United Nations General Assembly, in December 2006, declared 2009 the International Year on Natural Fibres. In doing so, it invited the FAO to facilitate the observance of the year, in collaboration with Governments, regional and international organizations, non-governmental organizations, the private sector and relevant organizations of the United Nations. The overall objective of the International Year is to raise the profile of natural fibres, and thus improve the welfare of farmers around the world. The strategy consists of four key areas of work:

1. To raise awareness and stimulate demand for natural fibres;
2. To encourage appropriate policy responses from the governments to problems faced by natural fibres industries
3. To foster an effective and enduring international partnership among the various natural fibres industries;
4. To promote the efficiency and sustainability of the Natural Fibres Industries.

This collection of papers is the proceedings of a one-day Symposium on Natural Fibres held at FAO HQs on 20 October 2008. The event had two main objectives: first, to generate and share information on the economic, social and environmental significance of natural fibres and second, to form an alliance among proponents of the various individual natural fibres that would facilitate the furthering of plans for 2009, the International Year on Natural Fibres. This section presents a summary of the debates which took place during the presentations and at the concluding round-table session.

NATURAL FIBRES

The International Steering Committee set up in 2005 to guide the activities of the IYNF, adopted a definition of natural fibres as "*those renewable natural fibres of plant or animal origin which can be easily transformed into a yarn for textiles*". This definition excludes man-made cellulose, wood fibre, synthetic materials such as polyester, and fur (on the skin) that cannot be easily transformed into a yarn. Natural fibres may be classified according to their origin as cellulosic (from plants), protein (from animals), or mineral. Cellulosic fibres may be seed hairs, such as cotton; bast (stem) fibres, such as linen; leaf fibres, such as sisal or husk fibres, such as coir from the coconut. Protein fibres include wool and hair, and secretions such as silk. The only important mineral fibre is asbestos, but nowadays it is of low economic importance due to its associated health problems.

ENVIRONMENTAL ISSUES

The economies of most developed countries depend to a large extent on the use of petrochemicals, which are not only becoming more expensive but that are also associated with the release of greenhouse gases. The bio-based economy, namely the use of renewable fuels and materials, can play its part in lowering this dependency. Dr John Williams from the National Non-Food Crops Centre presents a brief overview of the issues and challenges associated to this proposition. Intuitive feelings by consumers about the environmental value of natural fibres may not be sufficient to warrant it a place in the bio-based economy, and therefore much needs to be demonstrated by the natural fibre industry so as to generate a preference for these products vis-à-vis synthetic fibres.

A second paper by Jan van Dam from Wageningen University in The Netherlands explores the environmental benefits of natural fibre production and use. Starting with an analysis of the supply and value chain for various natural fibres, Van Dam presents a framework for carrying out a quantitative environmental impact assessment during the life-cycle of fibre products. Despite their complexities, the studies seem to conclude that the environmental impacts at farm level may be marginal relative to those observed at later stages of their life-cycles. Thus, the overall environmental performance of the life-cycle improves when residues and by-products are utilised instead of being discarded. He puts forward an agenda for R&D, including the exploration of the potential uses of “agro-residues”, namely options for a sustainable utilization of the by products of the natural fibre industry.

DEVELOPING COUNTRIES

Natural fibres are produced all over the world. Developed countries have important natural fibre industries, but in these large and diverse economies the economic contribution of natural fibres is minor compared to other industries. For some developing countries, however, natural fibres are of major economic importance: some examples are cotton in West African countries, jute in Bangladesh and sisal in Tanzania. In some cases, while fibres may look unimportant at the national level, they are of major local importance at the regional level, as is the case of jute in West Bengal (India) and sisal in North-Eastern Brazil. Proceeds from the sale and export of natural fibres often contribute significantly to the income and food security of resource-poor farmers and processors in least developed countries. There is a wide range of natural fibres and their applications range from apparel to industrial applications.

Six presentations underline a diversity of issues surrounding natural fibre production throughout the developing world. Rezaur Rahman from Bangladesh presents an overview of **jute** production in South Asia. Jute cultivation is the main income earning activity for millions of poor and marginal farmers, while related activities such as transportation, trading, industrial processing and production of diversified jute goods sustain the livelihoods of thousands of individuals, a considerable portion of which are women. However, the declining output and area cultivated, together with insufficient investments on R&D, are compromising the future of this fibre.

The potential of **cotton** for generating income and reducing poverty in West and Central Africa is explored by Karim Hussain from IFAD. A number of proposals and strategic directions are highlighted, notably value-addition that could be drawn from cotton production and trade, a process that would significantly contribute to promoting regional development, improving sustainable livelihoods and reducing poverty. However, this would require the development of a regional textiles industry, a course of action that would present many difficult challenges such as updating the technology and facing strong competition from low cost Asian textiles. Nevertheless, promising markets do exist, and the possibility of large scale investments for the development of a regional textiles industry, and fair trade and organic textiles should be explored. A number of examples of ongoing initiatives for increasing production, productivity and trade are described.

Small scale cultivation and processing of **sisal** offers many potential benefits to farmers in developing countries. Apart from fibre production, a wide range of applications can be found for its by products, such as animal feed and bio-fuel substrate. Dr David Machin describes a new approach that is being developed by the NGO Oxfam, in which over a period of 10 years a scale-up project is expected to involve some 100 000 Tanzanian farmers in the cultivation of this crop. Preliminary cash flow analysis suggests that farm credits can be easily repaid over a period of four years. Sisal hedges would be grown around the fields and along

roadsides and smallholder sisal farms would be established in which intercropping with food crops is possible.

Wool is by far the most important animal fibre in South America both in volume and value terms. Other animal fibres, ranked according to the volume produced include alpaca, llama, mohair, vicuña and guanaco. The bulk of all fine and good quality wools traded, with an aggregate export value of over \$US 500 million in 2007, originates mostly in large and medium scale commercial farms in Argentina, Uruguay, Chile and southern Brazil. Conversely, lower quality wool and other animal fibres are produced mostly in subsistence farms. Alpacas, llamas and vicuñas are typically found in high altitudes of the central Andes, while goats producing mohair or cashmere and guanacos are largely found in the Patagonian desert. The characteristics and socio-economic relevance of each of these animal fibres are described by Roberto Cardellino. Ben Lyons highlights the importance of the Australian wool industry and explains the efforts that are being carried out in the country to promote this product and to reduce on-farm emissions of greenhouse gases.

China is one of the largest producer, processor and consumer countries of natural fibres in the world. Professor Zhang presents an overview of all natural fibres, but mainly concentrates on **hemp**, a fibre which has been identified by the Chinese government as a promising crop for improving both farmers' food security and the environment. Prof. Zhang explains the process of transforming hemp into a material that resembles cotton (a process called cottonisation). The end product has many attractive physical properties, including humidity absorption, softness and heat resistance, and can be either used alone or blended with other fibres to produce a wide range of textiles. The country has a target of cultivating 1.3 million hectares of this crop, mostly in marginal agricultural land, that would produce an equivalent volume of 2 million tonnes of hemp.

Coir and its importance in Asia and the Pacific are detailed by Romulo Arancon. Coir is the thickest and most resistant of all commercial natural fibres, and its versatile nature allows a multitude of applications, including brushes, twine, geotextiles, planter pots, upholstery and rugs. The current challenges faced by the industry are described, including working conditions, productivity, technical change, value addition and institutional capabilities. A project financed by the CFC is used as an example of how to tackle some of these challenges.

RESEARCH AND DEVELOPMENT

In most – if not all – applications, natural fibres are subject to competition from manufactured substitutes, or so called synthetic fibres. However, the diversity of applications of natural fibres has increased significantly in recent years, following consumer awareness on environmental issues and an interest in western governments in seeking non-oil reliant products. Brett Sudell from ADAS, UK, describes numerous examples from various industries, including automotive, construction and leisure. Environmental issues prompted the Australian Wool Innovation to engage in a Life Cycle Analysis (LCA) of wool production in Australia. Ben Lyons offers an overview of the methodology, some conclusions and an agenda for research. Finally, Sarah Crumbley reviews innovations on cotton fabrics, including Stay True Cotton technology, Storm Denim and Wicking Windows.

FINAL CONSIDERATIONS

The presentations draw a complex picture of natural fibres. As mentioned in the introduction, natural fibres have been defined as “those renewable natural fibres of plant or animal origin which can be easily transformed into a yarn for textiles”, but this is where their similarities finish. The debate that followed the presentations attempted to capture some of the most

relevant policy, technology, and marketing issues relevant for the future of natural fibres, but with so many different types, each of which is produced by so many different producers all over the world, it was very difficult to draw general conclusions or recommendations.

Consider as an example the diversity of animal fibres produced in Argentina, where policy makers and researchers are faced with large scale and subsistence producers delivering bulk high quality merino wool produced in Patagonia or selling alpaca garments in remote villages of the Andes. Similar stories can be found for cotton, hemp and sisal. Nevertheless, the discussions highlighted some bottlenecks, as well as areas of research that, though tailor-made, suggest that much work is needed at the international level to project natural fibres into the future.

Some countries have been supporting their national fibre industries with the aid of the international community. One such opportunity is through projects financed by the Common Fund for Commodities. This organisation, which provides development assistance that focus on commodities, support actions in a vast array of fields, from productivity enhancement to value addition and research. For example the CFC in Tanzania has supported the improvement of sisal industry at two different levels: through improvements in the efficiency of extraction and through a more intensive use of its by-products¹.

On technology development, various examples were mentioned of the multitude of avenues that are currently being pursued, including GMOs, blends of fibres and treatments to enhance some of their properties. In addition to technology, it was noted that market research should also be carried to link retailers and brands with producers or innovative industries. Linking products to market opportunities is not a trivial exercise, and missing this link has been at the root of the failure of some development projects.

In terms of opportunities for small scale enterprises, the promotion of exports of crafts made of natural fibres was prominent. Many examples are available of small scale producers and processors of natural-fibre based products that have managed to develop export-oriented ventures with brands and retail companies in developed countries. Their competitive advantage appears to rely both on the originality of their designs as well as their competitive prices. As far as originality is concerned, most items are produced with indigenous knowledge which has not been replicated elsewhere. Their uniqueness is, to an extent, protected by the very nature of the tacit knowledge required to produce them. The diffusion of their know-how is difficult because it's produced with knowledge that has not been codified. However, while the secrecy of their technology works to their advantage, communities whose tradable outputs rely on tacit knowledge are constantly under threat. First, they may have difficulties in facing changing market conditions, in interpreting changes in "technical specifications" or in adapting their processes to comply with them. Second, there is a risk that their knowledge is eventually codified, and therefore that the product is reproduced elsewhere. In the latter, legislation exists in developed countries for protecting specific products, such as Geographical Indications or other types of certification systems, that could be applied to them, though it is not clear how effective their use can be in developing countries.



¹ CFC projects are regional in scope, and usually run for three to five years. Proposals that have a strong research component should make explicit the demand for the product concerned from the very early stages of project design, and should not only consider exporting to the European or North American markets, but also to large emerging markets such as Brazil, South Africa, India or China.

Certification and standards also need to be developed as a precondition for a more generalized use of individual natural fibres and their blends. A notorious example is in the field of construction. A whole range of new products is being tested, the knowledge of which is a prerequisite for relevant authorities to set up standards and certification systems. Technical specifications need to be developed concerning the safety and overall suitability of using these materials in various climates, for example properties such as insulation, combustibility, resistance to mould and mildew, etc., and these need to be communicated both to architects and consumers.

The Symposium concluded that the International Year of Natural Fibres represents an invaluable opportunity for raising the profile of the sector, provided a single stitch is found that allows them to effectively implement a joint strategy of lobby and advocacy for natural fibres as a whole.

Présentation générale du Symposium

En décembre 2006, l'Assemblée Générale des Nations Unies a proclamé l'année 2009 Année Internationale des Fibres Naturelles. Elle a ainsi invité la FAO à faciliter la célébration de l'Année, en collaboration avec les Gouvernements, les organisations régionales et internationales, les organisations non gouvernementales, le secteur privé et les organisations compétentes du système des Nations Unies. L'objectif général de l'Année Internationale est d'améliorer la visibilité des fibres et de contribuer ainsi à l'amélioration du bien-être des agriculteurs du monde entier. La stratégie est fondée sur quatre domaines d'activités essentiels :

1. Promouvoir les fibres naturelles et en stimuler la demande
2. Encourager l'adoption par les gouvernements de solutions appropriées aux problèmes auxquels sont confrontés les secteurs s'occupant des fibres naturelles
3. Stimuler un partenariat international efficace et durable entre les divers secteurs des fibres naturelles
4. Promouvoir l'efficacité et la durabilité des différents secteurs des fibres naturelles.

Ce recueil de documents correspond aux comptes-rendus du Symposium sur les fibres naturelles qui a eu lieu au siège de la FAO le 20 octobre 2008. Cet événement avait deux objectifs principaux : tout d'abord, de créer et de partager de l'information sur la portée économique, sociale et environnementale des fibres naturelles et ensuite, de former une alliance entre les représentants des différentes fibres naturelles afin de faciliter l'organisation de 2009, Année Internationale des Fibres Naturelles. Cette section présente un résumé des débats qui ont eu lieu lors des présentations et lors de la table ronde conclusive.

LES FIBRES NATURELLES

Le Comité d'orientation international, institué en 2005 afin d'orienter les activités de l'AIFN, a adopté la définition suivante des fibres naturelles : « *ces fibres naturelles renouvelables d'origine végétale ou animale qui peuvent être transformées facilement en fils destinés à la fabrication de textiles* ». Cette définition exclut les filés cellulosiques synthétiques, les fibres de bois, les matériaux synthétiques comme le polyester, et la fourrure (de pelleterie) qui ne peut pas être facilement transformé en fils. Les fibres naturelles peuvent être classées selon leur origine en tant que cellulosiques (d'origine végétale), protéiques (d'origine animale) ou minérales. Les fibres cellulosiques peuvent être des poils de graine, comme le coton ; des fibres libériennes (extraites de la tige), comme le lin, des fibres de feuille, comme le sisal ou des fibres extraites des écorces, comme le coir. Les fibres protéiques comprennent la laine et les poils, ainsi que les sécrétions, comme la soie. La seule fibre minérale importante est l'amiante, mais de nos jours, en raison des problèmes de santé qui y sont associés, elle est d'une faible importance économique.

QUESTIONS ENVIRONNEMENTALES

Les économies des pays les plus développés dépendent en très grande partie de l'utilisation des produits pétrochimiques, qui non seulement deviennent de plus en plus chers, mais sont également associés aux rejets de gaz à effet de serre. La bioéconomie, c'est-à-dire fondée sur l'utilisation de matériaux et combustibles renouvelables, peut participer à la réduction de cette dépendance. Le Dr John Williams du Centre National des Cultures Non Alimentaires présente une rapide vue d'ensemble des questions et des défis associés à cette thèse. La sensation intuitive des consommateurs au sujet de la valeur environnementale des fibres naturelles

pourraient ne pas être suffisante pour garantir aux fibres une place dans la bioéconomie, de sorte que l'industrie des fibres naturelles devra démontrer sa valeur environnementale avant que les consommateurs ne choisissent ses produits au détriment des fibres synthétiques.

Dans un deuxième document, Jan Van Dam, de l'Université de Wageningen aux Pays-Bas, s'intéresse aux avantages environnementaux de la production et de l'utilisation des fibres naturelles. À partir d'une analyse des chaînes de distribution et de valeur de diverses fibres naturelles, Van Dam présente un cadre permettant d'évaluer l'impact environnemental quantitatif lors du cycle de vie des produits à base de fibres. Il conclut que, malgré la complexité des études, les impacts environnementaux de ces produits au niveau de la production agricole sont négligeables par rapport à ceux qui sont observés lors des étapes successives de leur cycle de vie. Par conséquent, la performance environnementale globale du cycle de vie s'améliore lorsque les résidus et les sous-produits sont utilisés au lieu d'être rejetés. Il propose un programme de recherche et développement, y compris sur l'exploration des utilisations potentielles des « déchets agricoles », c'est-à-dire des options pour une utilisation durable des sous-produits de l'industrie des fibres naturelles.

PAYS EN DÉVELOPPEMENT

Les fibres naturelles sont produites partout dans le monde. Les pays développés possèdent d'importantes industries des fibres naturelles, mais dans ces grandes économies très diversifiées la contribution économique des fibres naturelles est mineure comparée aux autres industries. Cependant, dans certains pays en développement, celles-ci ont une importance économique majeure, par exemple, le coton dans certains pays d'Afrique de l'Ouest, le jute au Bangladesh et le sisal en République Unie de Tanzanie. Parfois, ces fibres ont une importance moindre au niveau national, mais elles occupent une place de premier plan dans l'économie locale de certains pays, comme c'est le cas pour le jute au Bengale Ouest (Inde) et le sisal dans le nord-est du Brésil. Les recettes des ventes et des exportations des fibres naturelles apportent souvent une contribution importante au revenu et à la sécurité alimentaire des agriculteurs pauvres et au secteur de la transformation dans les pays les moins avancés. Il existe une grande variété de fibres naturelles et leurs applications vont de la fabrication de vêtements à des applications industrielles.

Six présentations mettent en évidence de nombreuses questions qui entourent la production de fibres naturelles dans le monde en développement. Rezaur Rahman du Bangladesh présente une vue d'ensemble de la production de **jute** en Asie du Sud. La culture du jute est une des activités rémunératrices principales pour des millions d'agriculteurs pauvres et marginalisés, tandis que des activités connexes, telles que le transport, le commerce, le traitement industriel et la production de divers produits dérivés du jute, soutiennent les moyens de subsistance de milliers d'individus, dont une large proportion de femmes. Cependant, la diminution de la production et des zones cultivées, conjuguée à des investissements insuffisants dans la recherche et le développement, compromettent le futur de cette fibre.

Karim Hussain du FIDA examine le potentiel du **coton** de générer des revenus et de réduire la pauvreté en Afrique Centrale et de l'Ouest. De nombreuses propositions et orientations stratégiques sont mises en évidence, notamment l'ajout de valeur qui pourrait être tiré de la production et du commerce de coton, un processus qui contribuerait de manière significative à la promotion du développement régional, à l'amélioration des moyens de subsistance durables et à la réduction de la pauvreté. Cependant, cela nécessiterait le développement d'une industrie du textile régionale, un plan d'action qui présenterait de nombreux défis difficiles à relever, tels que la modernisation des technologies et la concurrence des textiles à bas coûts venant d'Asie. Néanmoins, il existe des marchés prometteurs, et il serait intéressant d'explorer la possibilité de réaliser des investissements à grande échelle pour le développement

d'une industrie du textile régionale, l'établissement d'un commerce équitable et la fabrication de textiles biologiques. L'étude décrit de nombreux exemples d'initiatives en cours dont le but est d'augmenter la production, la productivité et le commerce.

La culture et le traitement du **sisal** offrent de nombreux avantages potentiels aux agriculteurs des pays en développement. À côté de la production de fibres, il est possible de trouver une vaste gamme d'applications pour ces sous-produits, comme les aliments pour les animaux et le substrat pour les biocarburants. Le Dr David Machin décrit une nouvelle approche qui est actuellement développée par l'ONG Oxfam, qui devrait impliquer quelque 100 000 agriculteurs tanzaniens, sur une période de dix ans, dans un projet de production à grande échelle de cette culture. Les analyses préliminaires des flux de liquidités montrent que les crédits des fermes peuvent être rapidement remboursés, dans un délai de 4 ans. Des haies de sisal seraient cultivées autour des champs et le long des routes et de petites fermes de sisal seraient établies, dans lesquelles il serait possible de développer un système de culture intercalaire avec des cultures vivrières.

La **laine** est de très loin la fibre la plus importante en Amérique du Sud aussi bien en termes de volume que de valeur. Parmi les **autres fibres d'origine animale**, classées en fonction du volume produit, figurent : l'alpaga, le lama, le mohair, la vigogne et le guanaco. La majeure partie de toutes les laines fines et de bonne qualité commercialisée, d'une valeur d'exportation compressive de plus de 500 millions de US\$ en 2007, provient principalement de grosses et moyennes fermes commerciales d'Argentine, d'Uruguay, du Chili et du sud du Brésil. Au contraire, les laines de qualité inférieure et les autres fibres d'origine animale sont produites principalement dans des fermes de subsistance. Les alpagas, les lamas et les vigognes sont des animaux qui se trouvent principalement en haute montagne dans les Andes du centre, alors que les chèvres qui produisent le mohair ou le cachemire et les guanacos se trouvent majoritairement dans le désert de Patagonie. Les caractéristiques et la pertinence socio-économique de chacune de ces fibres d'origine animale sont décrites par Robert Cardellino. Ben Lyons souligne l'importance de l'industrie australienne de la laine, et explique les efforts réalisés par le pays pour promouvoir ce produit et pour réduire les émissions de gaz à effet de serre au sein des exploitations.

La Chine est un des plus grands pays producteurs, transformateurs et consommateurs de fibres naturelles dans le monde. Le Professeur Zhang présente une vue d'ensemble de toutes les fibres naturelles, mais il se concentre principalement sur le **chanvre**, une fibre que le Gouvernement chinois a identifiée comme une culture prometteuse en vue de l'amélioration, aussi bien de la sécurité alimentaire des agriculteurs que du respect de l'environnement. Le Prof. Zhang explique le processus qui permet de transformer le chanvre en un matériel similaire au coton (le processus de cotonisation). Le produit fini possède de nombreuses propriétés physiques intéressantes, notamment l'absorption de l'humidité, la douceur et la résistance à la chaleur, et peut être utilisé seul ou mélangé à d'autres fibres pour produire une vaste gamme de textiles. Le pays s'est fixé l'objectif de cultiver 1,3 million d'hectares de cette culture, principalement sur des terres agricoles marginales, pour une production d'un volume équivalent à 2 millions de tonnes de chanvre.

Dans sa présentation, Romulo Arancon s'intéresse au **coir** et à son importance en Asie et dans le Pacifique. Le coir est la plus épaisse et la plus résistante de toutes les fibres naturelles commerciales. De plus, sa nature versatile permet une multitude d'applications, notamment la fabrication de brosses, de corde, de géotextiles, de pots, de tapisseries et de tapis. La présentation décrit également les défis actuels auxquels doit faire face l'industrie, notamment les conditions de travail, la productivité, l'évolution des techniques, l'ajout de valeur et les capacités institutionnelles. Pour illustrer une manière de relever certains de ces défis, un projet financé par le FCP est donné en exemple.

RECHERCHE ET DÉVELOPPEMENT

Dans la plupart – si ce n'est dans toutes – les applications, les fibres naturelles sont sujettes à la concurrence des substituts manufacturés, également appelés fibres synthétiques. Cependant, la diversité des applications des fibres naturelles a nettement augmenté ces dernières années, en raison de la prise de conscience des consommateurs des questions environnementales et de la volonté des gouvernements occidentaux de trouver des produits qui ne dépendent pas du pétrole. Brett Sudell de l'ADAS, Royaume-Uni, décrit de nombreux exemples dans diverses industries, notamment dans les industries de l'automobile, du bâtiment et du loisir. Les problèmes environnementaux ont incité la Australian Wool Innovation à s'engager dans une analyse du cycle de vie (ACV) de la production de laine en Australie. Ben Lyon propose une vue d'ensemble de la méthodologie, certaines conclusions et un programme de recherche. Enfin, Sarah Crumbley analyse les innovations en matière de tissus de coton, notamment les technologies Stay True Cotton, Storm Denim et Wicking Windows.

CONSIDÉRATIONS FINALES

Les présentations dressent un portrait complexe des fibres naturelles. Comme il est fait mention dans l'introduction, les fibres naturelles ont été définies « *ces fibres naturelles renouvelables d'origine végétale ou animale qui peuvent être transformées facilement en fils destinés à la fabrication de textiles* », mais c'est là leur seul point commun. Le débat qui a suivi les présentations a tenté de capter certaines des questions ayant trait aux politiques, aux technologies et à la commercialisation les plus pertinentes pour le futur des fibres naturelles, mais en raison de l'énorme diversité des types de fibres, chacune étant produite par tellement de producteurs dans le monde entier, il a été très difficile de formuler des conclusions ou des recommandations générales.

La diversité des fibres d'origine animale produite en Argentine en est un exemple. En Argentine, les décideurs politiques et les chercheurs font face à des producteurs à grande échelle et à des producteurs de subsistance qui fournissent de la laine mérinos en vrac de grande qualité produite en Patagonie ou qui vendent des vêtements en alpaga dans des villages reculés des Andes. Il est possible de trouver des situations similaires pour le coton, le chanvre ou le sisal. Néanmoins, les discussions ont permis de mettre en évidence quelques rapprochements, ainsi que des champs de recherches qui, bien que spécifiques, suggèrent qu'il est nécessaire de fournir un énorme travail au niveau international pour propulser les fibres naturelles dans le futur.

Certains pays ont soutenu leurs industries nationales des fibres à l'aide de la communauté internationale. Ce type d'opportunités est possible notamment à travers des projets financés par le Fonds commun pour les produits de base. Cette organisation, qui fournit une aide au développement axée sur les produits de base, soutient des actions dans une vaste gamme de domaines qui vont de l'amélioration de la productivité à l'ajout de valeur et à la recherche. Par exemple, en Tanzanie, le FCP a soutenu l'amélioration de l'industrie du sisal à deux niveaux différents : grâce à une amélioration de l'efficacité au niveau de l'extraction et une utilisation plus intensive de ses sous-produits¹.



¹ Les projets du FCP ont une portée régionale, et durent généralement de trois à cinq ans. Les propositions ayant une forte composante de recherche devraient rendre explicite la demande du produit en question dès les premières étapes de la conception du projet, et ne devraient pas considérer uniquement la possibilité d'exporter vers les marchés européens ou nord-américain mais également vers les vastes marchés émergents comme le Brésil, l'Afrique du sud, l'Inde ou la Chine.

Pour ce qui est du développement des technologies, plusieurs exemples ont été mentionnés parmi la multitude de voies qui sont actuellement explorées, y compris les OGM, les mélanges de fibres, et les traitements pour améliorer certaines de leurs propriétés. Outre la technologie, il a été constaté qu'il était également nécessaire de mener des études de marché afin de mettre en contact les commerçants et les marques avec les producteurs ou les industries innovantes. Établir un lien entre les produits et les possibilités de marchés n'est pas une activité triviale, d'ailleurs, certains projets de développement ont échoué précisément en raison de l'absence de ce lien.

Concernant les possibilités pour les petites entreprises, la promotion de l'export d'artisanat produit à partir de fibres naturelles a été essentielle. Il existe de nombreux exemples de petits producteurs et transformateurs de produits à base de fibres naturelles qui ont réussi à développer des entreprises orientées vers l'export avec des marques et des sociétés de vente dans des pays développés. Il semble que leurs avantages compétitifs reposent aussi bien sur l'originalité de leur stylisme que sur la compétitivité de leur prix. Pour ce qui est de l'originalité, la plupart des produits est fabriquée à partir de savoir-faire locaux qui n'ont pas leur équivalent ailleurs. Leur unicité est, dans une certaine mesure, protégée par le caractère tacite des connaissances nécessaires à leur fabrication. La diffusion de leurs savoir-faire est difficile parce qu'il provient de connaissances qui n'ont pas été codifiées. Cependant, bien que le caractère secret de leurs techniques de travail joue en leur avantage, les communautés dont les produits commerciaux reposent sur des connaissances tacites sont constamment menacées. Premièrement, elles pourraient rencontrer des difficultés à faire face aux changements des conditions du marché, à interpréter des changements dans les « spécifications techniques » ou à adapter leurs processus de fabrication de manière à répondre à ces spécifications. Deuxièmement, il existe un risque que leurs connaissances viennent à être codifiées, et que leurs produits soient reproduits ailleurs. Concernant ce deuxième point, il existe dans les pays développés une législation qui protège certains produits spécifiques, comme les « Origines géographiques » ou d'autres types de système de certification, qui pourraient être appliqués à ces produits, bien qu'on ne sache pas vraiment dans quelle mesure leur utilisation serait efficace.

Afin de généraliser l'utilisation des fibres naturelles seules et mélangées, il est également nécessaire de développer des certifications et des normes. Prenons l'exemple du domaine de la construction. Une gamme entière de nouveaux produits est actuellement testée, les connaissances ainsi acquises permettront aux autorités compétentes d'établir des normes et des systèmes de certification. Il est indispensable de développer des spécifications techniques par rapport à la sécurité et, de manière plus générale, à la conformité d'utiliser ces matériaux sous différents climats, par exemple les propriétés telles que l'isolation, la combustibilité, l'aptitude au moulage et la résistance aux moisissures, etc., et celles-ci doivent être communiquées aux architectes et aux consommateurs.

La conclusion du Symposium est que l'Année Internationale des Fibres Naturelles représente une opportunité inestimable pour améliorer la visibilité du secteur, à condition de mettre en œuvre de manière efficace une stratégie conjointe de pression et de soutien en faveur des fibres naturelles dans leur ensemble.

Panorama general del Simposio

En diciembre de 2006 la Asamblea General de las Naciones Unidas declaró el 2009 como el Año Internacional de las Fibras Naturales, a la vez que invitaba a la FAO, en colaboración con los Gobiernos, las organizaciones regionales e internacionales, las organizaciones no gubernamentales, el sector privado y las organizaciones pertinentes de las Naciones Unidas, a facilitar la programación de sus actividades. El objetivo global del Año Internacional es realzar la importancia de las fibras naturales, para así contribuir a un mejor bienestar de los agricultores de todo el mundo. La estrategia consiste en cuatro esferas de trabajo principales:

1. Crear conciencia y estimular la demanda de fibras naturales;
2. Alentar que los gobiernos respondan con políticas apropiadas a los problemas que afrontan las industrias de las fibras naturales;
3. Promover una alianza internacional eficaz y duradera entre las diversas industrias de las fibras naturales;
4. Promover la eficacia y sostenibilidad de las industrias de las fibras naturales.

La presente colección de documentos corresponde a los trabajos del Simposio sobre las fibras naturales celebrado en la sede de la FAO el 20 de octubre de 2008. El evento tuvo dos objetivos principales: primero, generar y compartir información sobre la importancia económica, social y ambiental de las fibras naturales; y, segundo, constituir una alianza entre los presentadores de las diversas fibras naturales que facilitara la planificación del Año Internacional sobre las Fibras Naturales 2009. En esta sección se presenta un resumen de los debates que tuvieron lugar durante las presentaciones y en la mesa redonda conclusiva.

FIBRAS NATURALES

El Comité Directivo Internacional, establecido en 2005 para orientar las actividades del AIFN, adoptó como definición de fibras naturales *"aquellas fibras naturales renovables de origen vegetal o animal que se pueden transformar fácilmente en hilos para la fabricación de textiles"*. Esta definición excluye las celulósicas sintéticas, la fibra leñosa, los materiales sintéticos como el poliéster, las pieles (de peletería) que no pueden transformarse fácilmente en hilados. Según su origen, las fibras naturales pueden clasificarse en celulósicas (de origen vegetal), proteínicas (de origen animal), o minerales. Las fibras celulósicas pueden ser pelos de semilla, como el algodón; fibras blandas (tallo), como el lino; fibras de hoja, como el sisal, o fibras de pericarpio, como el coir (fibra de coco). Las fibras proteicas incluyen lanas y pelos; y secreciones, como la seda. La única fibra mineral importante es el asbesto (amianto), pero en la actualidad reviste poca importancia económica debido a los problemas sanitarios conexos.

CUESTIONES AMBIENTALES

Las economías de la mayoría de los países desarrollados dependen en gran medida del uso de productos petroquímicos, que además de ser cada vez más caros están relacionados con la liberación de gases de efecto invernadero. La economía de base biológica, que utiliza combustible y materiales renovables, puede contribuir a reducir esta dependencia. El Dr John Williams, del Centro Nacional de Cultivos con fines no alimentarios, presenta un breve resumen de los problemas y desafíos relacionados con esta tesis. La sensación intuitiva de los consumidores sobre el valor ecológico de las fibras naturales puede no ser suficiente para garantizarles un lugar en la economía de base biológica, de suerte que la industria de las fibras naturales tendrá que hacer mucho camino para lograr que se prefieran sus productos a las fibras sintéticas.

En un segundo documento, Jan Van Dam, de la Universidad holandesa de Wageningen, examina las ventajas ambientales de la producción y el uso de las fibras naturales. A partir de un análisis de la cadena productiva y de la cadena de valor de diversas fibras naturales, Van Dam presenta un marco para la evaluación del impacto ambiental cuantitativo durante el ciclo vital de los productos fibrosos. Llega a la conclusión de que, pese a la complejidad de los estudios, el impacto ambiental de dichos productos en las explotaciones puede ser marginal respecto del que se observa en las etapas posteriores de su ciclo vital. De ahí que los resultados ambientales globales del ciclo vital mejoren cuando se utilizan los residuos y productos derivados y no se descartan. Propone un programa de investigación y desarrollo, que incluye el estudio de los usos posibles de los “residuos agrícolas”, o sea opciones para una utilización sostenible de los productos derivados de la industria de las fibras naturales.

PAÍSES EN DESARROLLO

Las fibras naturales se producen en todo el mundo. Los países desarrollados tienen industrias importantes de fibras naturales, pero su aporte económico es menor en estas economías grandes y diversas que el de otras industrias. En cambio, en algunos países en desarrollo las fibras naturales revisten una importancia económica mayor, por ejemplo el algodón en los países de África occidental, el yute en Bangladesh y el sisal en Tanzania. En algunos casos, aunque las fibras pueden parecer no importantes en el plano nacional, lo son a nivel regional, como el yute en Bengala occidental (India) y el sisal en el nordeste del Brasil. A menudo el producto de la venta y exportación de las fibras naturales contribuye significativamente a los ingresos y a la seguridad alimentaria de los agricultores y procesadores con pocos recursos de los países menos adelantados. La gama de las fibras naturales es amplia, y sus aplicaciones van desde la fabricación de prendas de vestir a las aplicaciones industriales.

Seis presentaciones destacan una serie de cuestiones que rodean la producción de las fibras naturales en el mundo en desarrollo. Rezaur Rahman, de Bangladesh, presenta una visión panorámica de la producción de **yute** en Asia meridional. El cultivo del yute es la principal fuente de ingresos de millones de agricultores pobres y marginados, a la vez que las actividades conexas, tales como el transporte, la comercialización, el procesamiento industrial y la producción de productos de yute diversificados sustentan los medios de subsistencia de miles de personas, de las cuales las mujeres constituyen una parte considerable. Sin embargo, la disminución de la producción y de la superficie cultivada, junto con unas inversiones insuficientes en la investigación y el desarrollo, están comprometiendo el futuro de esta fibra.

El potencial del **algodón** para generar ingresos y reducir la pobreza en África occidental y central es el tema examinado por Karim Hussain, del FIDA. En dicho estudio se señalan algunas propuestas y orientaciones estratégicas, principalmente la adición de valor que podría obtenerse de la producción y el comercio del algodón, un proceso que podría contribuir notablemente a la promoción del desarrollo regional, a mejorar los medios de subsistencia sostenibles y a reducir la pobreza. Pero ello requeriría el desarrollo de una industria regional de textiles, lo que supone una serie de problemas difíciles de resolver, tales como la actualización de la tecnología y el hacer frente a la fuerte competencia de los textiles asiáticos de bajo costo. Ello no obstante, existen mercados prometedores, y habría que estudiar la posibilidad de realizar inversiones en gran escala para el desarrollo de una industria regional de textiles, así como la posibilidad de un comercio leal y de la fabricación de textiles orgánicos. En el estudio se describen algunos ejemplos de iniciativas en curso para aumentar la producción, la productividad y el comercio.

El cultivo y procesamiento del **sisal** ofrece muchas ventajas potenciales para los agricultores de los países en desarrollo. Además de la producción de fibra, se puede encontrar una

amplia gama de aplicaciones para sus productos derivados, tales como piensos y sustratos de biocombustible. El Dr David Machin describe un sistema nuevo elaborado por la ONG Oxfam, en el que se prevé un proyecto para la intensificación de este cultivo durante un período de diez años en el que participarán unos 100 000 productores tanzanianos. Un análisis provisional de flujo de fondos indica que los créditos agrícolas pueden reembolsarse fácilmente en un plazo de cuatro años. Se colocarían cercas de sisal en los campos y en los bordes de las carreteras, y se establecerían pequeñas fincas de sisal en las que puedan intercalarse cultivos alimentarios.

La **lana** es por lejos la fibra animal más importante en América del Sur tanto en volumen como en valor. Entre las **otras fibras de origen animal**, clasificadas en función del volumen producido, figuran la alpaca, la llama, el mohair, la vicuña y el guanaco. La mayor parte de todas las lanas finas y de buena calidad comercializadas, por un valor total de exportación de más de 500 millones de \$US en 2007, se origina principalmente en las fincas comerciales de grande y mediana escala de Argentina, Uruguay, Chile y el sur del Brasil. La lana de calidad inferior y las fibras de otros animales se producen principalmente en fincas de subsistencia. Las alpacas, llamas y vicuñas se encuentran normalmente en las grandes altitudes de los Andes centrales, mientras que las cabras que producen el mohair o la cachemira y los guanacos se encuentran principalmente en el desierto patagónico. Las características y la relevancia socioeconómica de cada una de estas fibras de origen animal están descritas por Roberto Cardellino. Ben Lyons destaca la importancia de la industria lanera australiana y explica los esfuerzos que se están desplegando en el país para promover este producto y reducir en las explotaciones las emisiones de gases de efecto invernadero.

China es uno de los mayores países productores, procesadores y consumidores de fibras naturales. El Profesor Zhang presenta un panorama de todas las fibras naturales, pero concentrándose principalmente en el **cáñamo**, una fibra que el Gobierno chino ha identificado como un cultivo prometedor para mejorar tanto la seguridad alimentaria de los agricultores como el medio ambiente. El Prof. Zhang explica el proceso de transformación del cáñamo en un material semejante al algodón (proceso de algodonización). El producto final tiene muchas propiedades físicas interesantes, tales como la absorción de la humedad, la suavidad y la resistencia al calor, y puede utilizarse tanto separadamente como mezclado con otras fibras para producir una amplia gama de textiles. El país tiene como objetivo la siembra de 1,3 millones de hectáreas con este cultivo, principalmente en tierras agrícolas marginales, lo que produciría un volumen equivalente de 2 millones de toneladas de cáñamo.

El **Bonote** y su importancia en Asia y el Pacífico es el tema de la ponencia de Rómulo Arancon. El bonote es la fibra más gruesa y resistente de todas las fibras naturales comerciales, y su versatilidad permite una multitud de aplicaciones, tales como cepillos, bramante, geotextiles, macetas, tapizados y alfombras. Se describen algunos problemas a los que se enfrenta actualmente la industria, tales como las condiciones laborales, la productividad, el progreso técnico, la adición de valor y las capacidades institucionales, y se utiliza un proyecto financiado por el FCPB como ejemplo de cómo pueden resolverse.

INVESTIGACIÓN Y DESARROLLO

En la mayoría de las aplicaciones, si no en todas, las fibras naturales están sujetas a la competencia de los sustitutos manufacturados, las así llamadas fibras sintéticas. Sin embargo, la diversidad de las aplicaciones de las fibras naturales ha aumentado considerablemente en los últimos años, debido a una sensibilización de los consumidores a las cuestiones ambientales y al interés de los gobiernos occidentales por los productos no dependientes del petróleo. Brett Sudell, de ADAS, Reino Unido, describe numerosos ejemplos tomados de diversas industrias (automotriz, constructora, y de esparcimiento). Los problemas ambientales

impulsaron a la Australian Wool Innovation a realizar un análisis del ciclo vital (LCA) de la producción lanera en Australia. Ben Lyons ofrece un panorama de la metodología, algunas conclusiones y un programa de investigación. Por último, Sarah Crumbley examina las innovaciones registradas en las fábricas de algodón, incluidas las tecnologías Stay True Cotton, Storm Denim y Wicking Windows.

CONSIDERACIONES FINALES

Las presentaciones trazan un cuadro complejo de las fibras naturales. Como se ha indicado en la introducción, se ha definido a las fibras naturales como *“aquellas fibras naturales renovables de origen vegetal o animal que se pueden transformar fácilmente en hilos para la fabricación de textiles”*, pero ahí terminan las semejanzas. En el debate que siguió a las presentaciones se trató de captar algunas de las cuestiones de políticas, tecnología y comercialización más pertinentes para el futuro de las fibras naturales, pero tratándose de tantos tipos diferentes, y cada uno producido por tantos productores diferentes de todo el mundo, fue muy difícil formular conclusiones generales o recomendaciones.

Un ejemplo se tiene en la diversidad de fibras de origen animal producidas en la Argentina, donde las autoridades y los investigadores se encuentran con productores en gran escala y con productores de subsistencia que entregan a granel lana merino de buena calidad producida en la Patagonia o venden ropa de alpaca en aldeas remotas de los Andes. Lo mismo podría decirse del algodón, el cáñamo y el sisal. No obstante, las discusiones destacaron algunas dificultades críticas, así como esferas de investigación que, aunque personalizadas, indican la necesidad de una gran labor a nivel internacional para proyectar las fibras naturales hacia el futuro.

Algunos países han ido apoyando sus industrias nacionales de fibras con la ayuda de la comunidad internacional. Los proyectos financiados por el Fondo Común para los Productos Básicos es una posibilidad. Esta organización, que proporciona una ayuda para el desarrollo centrada en los productos básicos, apoya iniciativas en una vasta gama de sectores, desde el aumento de la productividad a la adición de valor y la investigación. Por ejemplo, en Tanzania el FCPB ha apoyado el mejoramiento de la industria del sisal en dos niveles diferentes: mediante una mejora de la eficacia de la extracción y mediante un uso más intensivo de sus productos derivados¹.

Sobre el desarrollo de la tecnología, se mencionaron diversos ejemplos de una multitud de caminos que se están transitando actualmente, incluidos los OMG, las mezclas de fibras, y los tratamientos destinados a mejorar algunas de sus propiedades. Además de la tecnología, se observó que debían realizarse también estudios de mercado para poner en contacto a minoristas y marcas con los productores o las industrias innovadoras. Establecer un vínculo entre los productos y las oportunidades de mercado no es una actividad de poca monta; algunos proyectos de desarrollo fallaron precisamente por la falta de tal conexión.

En lo que se refiere a las oportunidades para empresas de pequeña escala, ha sido muy importante la promoción de las exportaciones de artesanías hechas de fibras naturales. Hay muchos ejemplos de pequeños productores y procesadores de productos derivados de fibras naturales que han logrado crear empresas orientadas a la exportación con marcas y empresas minoristas en los países desarrollados. Su ventaja competitiva depende tanto de

1 Los proyectos de FCPB son de alcance regional, y generalmente duran de tres a cinco años. Las propuestas que tienen un componente fuerte de investigación deberían explicitar la demanda del producto en cuestión desde las fases muy iniciales del diseño del proyecto, y no deberían examinar solamente las exportaciones a los mercados europeos o norteamericanos, sino también a los grandes mercados emergentes como Brasil, Sudáfrica, la India o China.

la originalidad de sus diseños como a sus precios competitivos. En cuanto a la originalidad, la mayoría de los artículos se producen en base a conocimientos indígenas, totalmente exclusivos. Su peculiaridad está protegida, en cierta medida, por el carácter tácito de los conocimientos requeridos para su producción. La difusión del secreto "profesional" es difícil porque se trata de conocimientos no codificados. Sin embargo, aunque el secreto de su tecnología obra en su favor, las comunidades cuyos productos comercializables dependen de conocimientos tácitos se encuentran bajo una amenaza constante. En primer lugar, porque pueden tener dificultades para enfrentar las variaciones del mercado, interpretar los cambios registrados en las "especificaciones técnicas", o adaptar sus procedimientos a las especificaciones establecidas. En segundo término, porque existe el riesgo de que tarde o temprano sus conocimientos logren codificarse, y sus productos se reproduzcan en otras partes. En el segundo caso, para la protección de determinados productos existe en los países desarrollados una legislación, tal como las "Indicaciones geográficas" u otros tipos de sistemas de certificación, que podría aplicarse a ellos, aunque no es tan claro en qué medida pueda ser eficaz en los países en desarrollo.

Para un uso más generalizado de las fibras naturales individuales y de sus mezclas se impone también la elaboración de certificaciones y normas. Un ejemplo muy conocido es el del sector de la construcción. Se está ensayando toda una serie de nuevos productos, cuyo conocimiento es una condición indispensable para que las autoridades pertinentes establezcan normas y sistemas de certificación. Es necesario elaborar especificaciones técnicas concernientes a la seguridad y, en general, a la conveniencia de utilizar dichos materiales en diversos climas, por ejemplo las propiedades tales como el aislamiento, la combustibilidad, la resistencia al moho y el mildiú, etc., que han de comunicarse tanto a los arquitectos como a los consumidores.

El Simposio llegó a la conclusión de que el Año Internacional de las Fibras Naturales representa una oportunidad inestimable para realzar la importancia del sector, siempre y cuando se encuentre la oportunidad de ejecutar una estrategia conjunta de presión a favor de las fibras naturales en conjunto y de promoción de las mismas.

天然纤维专题研讨会

研讨会概况

2006年12月，联合国大会宣布2009年为国际天然纤维年。为此，联大请粮农组织与各国政府、区域和国际组织、非政府组织、私营部门及联合国有关组织通力协作，协调举办国际天然纤维年的活动。举办国际天然纤维年的宗旨是提升天然纤维的地位，从而改善世界各地广大农民的民生。其战略由四个主要领域的工作组成：

1. 提高认识，刺激天然纤维的需求；
2. 鼓励各级政府对天然纤维产业面临的问题采取适当的政策对策；
3. 促进各类天然纤维产业之间的持久有效的国际伙伴关系；

2008年10月20日在粮农组织总部举办了为期一天的天然纤维研讨会，本论文集即为其论文汇编。该研讨会主要有两个目的：首先是生成和交流有关天然纤维在经济、社会和环境方面重要性的信息，其次是在各种天然纤维的倡导者之间结成联盟，从而进一步推动2009国际天然纤维年各项计划的落实。研讨会发言和圆桌总结会期间进行了讨论，本节即是对讨论内容的概要总结。

天然纤维

为指导国际天然纤维年活动而于2005年成立的国际指导委员会采纳了以下天然纤维的定义：“可易于加工成为纺织纱线的可再生的植物或动物来源的天然纤维”。这一定义排除了人造纤维素、木质纤维、聚酯等合成材料以及不易于加工成为纱线的（附着皮革的）毛皮。天然纤维可根据其来源划分为纤维素（源自植物）、蛋白质（源自动物）或矿物质。纤维素纤维可以是种毛，如棉花；麻（茎）纤维，如亚麻；叶纤维，如剑麻；亦或壳纤维，如椰棕。蛋白质纤维包括羊毛和毛发，以及丝等分泌物。惟一具有重要意义的矿物质纤维是石棉，但由于其引起的健康问题，现今石棉的经济意义不大。

环境问题

多数发达国家经济体在很大程度上依赖使用石化产品，这些产品不但价格日渐昂贵，也会造成温室气体的排放。以生物为基础的经济，即采用可再生燃料和材料的经济方式可以在降低这一依赖程度方面发挥作用。国家非粮食作物中心的John Williams博士对涉及这一论点的问题和挑战进行了简要介绍。消费者对天然纤维环境意义的直觉感受可能不足以确保其在以生物为基础的经济中占有一席之地，因此天然纤维产业需要花大力气进行示范，以便培育对这些产品相对于合成纤维的偏好。

来自荷兰瓦特宁根大学的Jan Van Dam的另一个发言探讨了天然纤维生产和使用对环境的益处。该文从对各种天然纤维的供应和价值链的分析入手，阐述了在纤维产品生命周期中进行定量环境影响评估的框架。作者结论认为，虽然有关研究十分复杂，但与纤维产品生命周期的后期环节相比，在农场一级的环境影响微小。因此，如果残留物和副产品能得到利用而不是丢弃的话，生命周期的总体环境表现将得到改善。作者提出了进行

研究开发的日程安排，包括开发“农业残留物”的潜在用途，即对天然纤维产业副产品进行可持续利用的方案。

发展中国家

天然纤维在世界各地均有生产。发达国家的天然纤维产业具有重要地位，但在这些巨大且多样化的经济体中，与其他产业相比天然纤维的经济贡献率较小。但对于一些发展中国家来说，天然纤维具有重要的经济意义：例如西非国家的棉花、孟加拉国的黄麻和坦桑尼亚的剑麻。在某些情况下，虽然纤维在全国范围看似无足轻重，但从地区层面却对当地具有重要意义，例如（印度）西孟加拉邦的黄麻和巴西东北部的剑麻。从事天然纤维销售和出口活动往往对最不发达国家资源贫乏的农民和加工者的收入和粮食安全具有重要贡献。天然纤维的种类很多，其用途从服饰到各种工业应用不一而足。

有六个发言围绕发展中国家天然纤维生产的一系列问题进行了阐述。来自孟加拉国的Rezaur Rahman介绍了南亚黄麻生产情况。黄麻种植是数百万贫困和边缘化农民创收的主要来源，而各种黄麻制品的运输、贸易、工业加工和生产等有关活动养活了成千上万人，其中很大一部分是妇女。但产量和种植面积的下滑，加上对研发投资不足，制约了这一纤维今后的发展潜力。

来自农发基金的Karim Hussain探讨了棉花在帮助西部和中部非洲创收和减贫方面的潜力。他提出了若干建议和战略方向，特别是棉花生产和贸易环节的增值问题，棉花的生产和贸易能够为促进区域发展、改善可持续生计和减贫做出重要贡献。但这将需要对区域纺织工业进行培育，这一过程面临不少严峻挑战，例如需要对技术进行升级且面临亚洲低成本纺织品的激烈竞争。尽管如此，市场前景仍十分可观，应该探讨对区域纺织工业发展进行大规模投资的可能性以及公平贸易和有机纺织品的问题。该发言还阐述了一系列旨在增加产量、生产率和贸易的现有项目的实例。

小规模剑麻种植和加工对发展中国家的农民带来许多潜在利益。除纤维生产外，剑麻的副产品也有广泛用途，例如动物饲料和生物燃料基质。David Machin博士阐述了非政府组织“乐施会”正在开发的一项新方法，预计在10年期间内一项推广项目将使用这一方法组织约10万坦桑尼亚农民开展剑麻种植。初步的现金流分析显示，农业信贷可以在四年时间内轻松偿还。田边和沿路将种植剑麻树篱，还将建立小型剑麻农场，可以与粮食作物进行间作。

无论从数量还是金额来看，羊毛无疑是南美洲最重要的动物纤维。根据产量多寡排序，其他动物纤维包括驼羊、羊驼、安哥拉山羊、小羊驼和原驼。2007年，优质纯细羊毛出口总金额达5亿美元以上，其贸易量的大部分主要来自阿根廷、乌拉圭、智利和巴西南部的大中型商业化农场。与此相反，较低质量的羊毛和其他动物纤维则主要是由温饱型农户出产的。驼羊、羊驼和小羊驼常见于安第斯山脉中麓高海拔地带，而出产马海毛或羊绒的山羊及原驼则主要分布在巴塔哥尼亚沙漠。Roberto Cardellino阐述了这些动物纤维各自的特点和社会经济意义。Ben Lyons着重探讨了澳大利亚羊毛产业的重要性并介绍了该国为推广这一产品和降低田间温室气体排放而正在开展的工作。

中国是世界最大的天然纤维生产国、加工国和消费国。张教授对所有天然纤维都做了简要介绍，但重点为大麻。中国政府将该纤维确定为提高

农民粮食安全水平和改善环境质量的一个大有前途的作物。张教授阐述了把大麻加工为类似于棉花的材料的工艺（该工艺称为“绵化处理”）。其最终产品具有许多优良的物理特性，包括吸潮、柔软和耐热，既可单独利用，也可以与其他纤维混纺，制作多种织物。该国计划种植130万公顷大麻，主要利用贫瘠农田，产量折合200万吨大麻。

Romulo Arancon详尽阐述了椰棕的情况及其在亚洲和太平洋地区的重要性。椰棕在所有商业化天然纤维中厚度最大，抗耐性最强，其多面性使其具有多重用途，包括刷子、麻绳、土工布、花盆、坐垫和小地毯等。还阐述了该产业目前面临的挑战，其中包括工作条件、生产率、技术变革、增值和制度能力。引用了一项由商品共同基金资助的项目作为事例，说明了应对其中某些挑战的方式。

研究与开发

在多数——甚至所有用途中，天然纤维都面临制造业替代品，即合成纤维的竞争。但近年来，随着消费者对环境问题的认识和西方国家政府寻求非依赖石油产品的兴趣不断提高，天然纤维用途的多样性大有提高。来自英国ADAS咨询公司的Brett Sudell列举了各个产业的众多事例，包括汽车制造业、建筑业和休闲娱乐。处于环境问题考虑，澳大利亚羊毛发展局对澳大利亚羊毛生产进行了生命周期分析。Ben Lyons对方法、某些结论和研究安排进行了概要说明。最后，Sarah Crumbley总结了棉纺领域的创新发展情况，包括“保真棉花”技术、“风暴牛仔”和“微型窗”等。

结论

会议发言的内容体现了天然纤维的复杂性。如序言所述，天然纤维的定义是“可易于加工成为纺织纱线的可再生的植物或动物来源的天然纤维”，但各种天然纤维的共同点也仅此而已。会议发言之后进行了讨论，目的是找出与天然纤维未来发展有关的最具相关性的一些政策、技术和市场问题，但由于天然纤维种类繁多，其中每一种又是由全世界众多千差万别的生产者所生产的，因此很难提出一般性结论或建议。

阿根廷是动物纤维生产多样性的典型例子，该国的政策制定人员和研究人員面对的既有大规模生产者，也有温饱型生产者，他们或大量提供巴塔哥尼亚优质美利奴羊毛，或仅在安第斯山脉边远的村落出售驼羊服装。棉花、大麻和剑麻也有类似情况。尽管如此，会议仍重点探讨了一些瓶颈问题和研究的领域，虽然这些研究是专门定制的，但却显示国际层面还需要花大力气来推动未来天然纤维的发展。

一些国家在国际社会的援助下对本国纤维产业给予了扶持。其中一个机遇是开展商品共同基金资助的项目。该组织提供的发展援助以商品为重点，在从提高生产率到增值和科研的广泛领域提供行动支持。例如，商品共同基金在坦桑尼亚从两个层面对剑麻产业升级给予了支持：一是通过提取效率，二是通过提高其副产品的利用水平。¹

1 商品共同基金项目的范围具有区域性，通常为期三至五年。含有大量研究内容的项目的建议应在项目规划的初期就有关产品提出明确要求，不仅应考虑向欧洲或北美市场出口，也应考虑向巴西、南非、印度或中国等新兴大市场出口。

在技术开发方面，列举了各种事例说明当前为改善纤维的某些特性而采用的众多方法，包括转基因生物、纤维混配和处理。除技术因素外，会议提及还应进行市场研究，把零售商和品牌与生产者或创新型产业联系起来，产品与市场机遇的对接不是细枝末节，这正是一些开发项目遭受失败的根源所在。

在小型企业的机遇方面，促进天然纤维制作的工艺品的出口十分重要。众多事例说明，小型天然纤维产品生产和加工企业成功地与发达国家的品牌和零售企业合作开辟了出口型业务。它们的竞争优势似乎既依赖于产品设计的独创性，也依靠具有竞争力的价格。在独创性方面，多数产品都是借助当地知识生产的，这些知识尚未被复制到其他地方。从某种意义上说，其独特性是由生产这些产品所需的隐性知识的特性所保护的。由于生产知识尚不成文，因此生产工艺的推广难度大。然而，虽然技术的私密性对生产者有利，但产品依靠隐性知识的社区却常常面临威胁。首先，他们可能难以适应市场条件的变化，难以解读“技术规格”的变动，也难以根据“技术规格”的要求调整工艺。其次，存在有朝一日他们的知识成为文字的风险，从而造成其他地方对产品进行仿造。在后一种情况下，发达国家有法律制度对特殊产品进行保护，例如地理标识或其他类型的认证系统，这些产品可以适用这些法律。但在发展中国家采用这一制度的效果如何尚不得而知。

还需要设计认证制度和各项标准，这是扩大各种天然纤维及其混纺产品用途的一个前提。一个负面的例子是在建筑领域。目前正在对一整系列新产品进行试验，对这些产品的了解是有关当局制定标准和认证体系的前提。应制定有关产品安全性以及在不同气候条件下使用这些材料的适当性的技术规格，例如绝缘性、可燃性、抗霉菌性等，这些工作需要与生产者和消费者进行沟通。

专题研讨会的结论认为，国际天然纤维年是提高该产业影响的宝贵契机，但条件是要找到适当途径，使有关方面能够有效地实施联合战略，为天然纤维进行整体游说和倡导。

Is There a place for natural fibres in the emerging bioeconomy?

John Williams, The National Non-Food Crops Centre, UK

The drivers towards a more sustainable economy are familiar, but worth reiterating. The global population is growing and all the new inhabitants will want to be clothed, kept warm and fed. Currently, we are dependent on finite petrochemicals, which are not only going to become more expensive, but are also associated with the release of greenhouse gases. One solution is to increase our use of renewable fuels and materials. Natural fibre producers will have to recognise the part they can play in this emerging bioeconomy. We may well be running out of oil, but it doesn't follow that natural fibres can replace synthetics – bio-based synthetics also have a role to play.

THE VALUE PROPOSITION OF RENEWABLES

The renewable carbon in renewable fibres provides a means to manage carbon in a sustainable manner. Petrochemicals were once living organisms and the carbon they contain is the product of ancient photosynthesis. Petrochemicals are formed over a geological timescale, so their large-scale use for fuels and materials means they are finite on a human time scale. The GHG released by the use of fossil fuels also contributes to climate change. However, by using renewable fibres, and thus renewable carbon, we can manage carbon in a more sustainable way and reduce the net gain of GHGs in the atmosphere.

NATURAL FIBRES DO HAVE UNIQUE PROPERTIES...

As well as being renewable, natural fibres have many properties that are unavailable through synthetic fibres, or cannot be achieved without prohibitive expense. The automotive industry has prized natural fibres for their strength and weight-saving properties for many decades. Construction also has many applications for natural fibres such as structural walls made with hemp and lime, insulation made from sheep's wool, and flexible composite membranes.

... BUT IT'S FUNCTIONALITY THAT COUNTS

However, when performance counts for so much the sustainability of natural fibres is not enough. The unique properties of natural fibres may not translate well into a functional product. Furthermore, synthetic fibres can be manufactured on a large scale (which means energy efficiency) and generally give a consistent product. It is difficult from a technical and sustainable perspective to scale-up the production of some natural fibres. It is now possible to use biological material as a feedstock for producing bulk chemicals that can then be turned into fibres. If we can make polyester that's identical to a petrochemical-derived fibre, but is simply made from biomass, then need we be concerned that this is not a 'natural' fibre?

Take polylactic acid (PLA) as an example. PLA is made from corn, so it is a renewable-carbon-based polymer. It's most familiar guise is in packaging, but it can also be extruded into fibres that can be used in everything from jumpers to geotextiles. For example, Ingeo™, a PLA fibre from NatureWorks is used in 320 nonwoven and textile products.

Using 1000 tons of Ingeo instead of polypropylene could save the equivalent of 4418 barrels of oil. A new, second generation of PLA is also on the way, that will have even greater functionality. PLA is not a 'natural' fibre, but it has the environmental benefits of renewable carbon and it can be made in high volumes. It also illustrates the opportunities for the fibre industry in general to create blends of natural, renewable and synthetic fibres to give a consistent product or particular functionality.

BIOCOMPOSITES

Natural fibres and resins can be combined to make to make biocomposite materials. However, the continuing reliance on petrochemical-derived resins is a considerable environmental drawback. One major goal is to make suitable composites containing only renewable materials, i.e. both fibres and resins derived from biomass. Several of these 100% renewable biocomposites are now available, for example PolyFlax, which has fibres and resin derived from sugarcane. Demands for new high-tech materials in the automotive and aerospace industries could provide an increasingly large market for biocomposites that use natural fibres and biobased resins and polymers.

THE FUTURE

In the future there will be a place for natural fibres and bio-based synthetic fibres – one need not be a threat to the other. But producers of both types of material will have to consider both the markets for their products and the full life cycle environmental impact of their products. Intuitive feelings about the environmental value of natural products are not sufficient to warrant a place in the emerging bioeconomy. At a time when consumers grow ever more suspicious about greenwashing, it is important to demonstrate that a natural fibre is truly a sustainable alternative, and to demonstrate that material functionality will not be compromised by using bio-based materials.

Environmental benefits of natural fibre production and use

Jan E.G. van Dam Wageningen University, The Netherlands

INTRODUCTION

The year 2009 has been assigned by the UN to be the international year of natural fibres. Natural fibre industries employ millions of people all over the world, especially in the developing countries. As the major non-food commodity natural fibres and their products are processed in many small and large industries and consumers all over the world profit from the provided products. The promotion of the use of natural fibres as CO₂ neutral resource is believed to contribute to a greener planet. So the question arises: how can the evolvement of the global bio-based economy be the solution for sustainable developments? And are natural fibres the solution towards environmental improvement? This paper addresses the various issues that occur when the environmental impact of natural fibres is critically evaluated.

The transition towards a bio-based economy and sustainable developments as a consequence of the Kyoto protocols on greenhouse gas reduction and CO₂ neutral production offers high perspectives for natural fibre markets. Changing to a bio-based economy requires substitution of common raw materials that are currently largely produced from fossil (petrochemical) or mineral resources, by products produced from renewable (plant and animal based) resources. Development of a sustainable global economy, which permits improving purchasing power and living standards without exhaustion of resources for future generations, requires a fundamental change in attitude. On ecological grounds products should then be preferred that are based on photosynthetic CO₂ fixation. The benefit of those sustainable resources is that they can be regrown within the foreseeable future, without negative side-effects on global bio-diversity. Therefore, competitive products based on renewable resources need to be developed that have high quality, show excellent technical performance and harm the environment less than current products based on petrochemical materials.

DEFINITION OF NATURAL FIBRE

Natural fibres can be defined as bio-based fibres or fibres from vegetable and animal origin (table 1). This definition includes all natural cellulosic fibres (cotton, jute, sisal, coir, flax, hemp, abaca, ramie, etc.) and protein based fibres such as wool and silk. Excluded here are mineral fibres such as asbestos that occur naturally but are not bio-based. Asbestos containing products are not considered sustainable due to the well known health risk, that resulted in prohibition of its use in many countries. On the other hand there are manmade cellulose fibres (e.g. viscose-rayon and cellulose acetate) that are produced with chemical procedures from pulped wood or other sources (cotton, bamboo). Similarly, regenerated (soybean) protein, polymer fibre (bio-polyester, PHA, PLA) and chitosan fibre are examples of semi-synthetic products that are based on renewable resources. In this paper also the use of fibres in food industries is excluded, where in recent years these are frequently promoted as dietary fibres or as supplements for health products.

VALUE ADDITION IN FIBRE CONVERSION

Practically everywhere and in all countries natural fibres are produced and used to manufacture a wide range of traditional and novel products from textiles, ropes and nets, brushes, carpets and mats, mattresses to paper and board materials. The long fibres are transformed to threads or yarns that are used to join, connect or attach and to form bonds, networks or weaves.

The fibre and textiles industries are among the most labour-intensive sectors and therefore stimulate the industrialisation in cheap labour countries. Textiles production is often a major economic output for these countries. However, in many of the less developed countries the fibre and textile sectors are still poorly developed, but offer perspective for socio-economic development.

This development should be sustainable and therefore not at the expense of the environment or exploiting workers. In the value addition chain of fibre crop production and supply to markets various environmental impacts can be distinguished. The impact factor on the environment is related to the production volumes of fibre products and the size of the end-use market.

Cotton is by far the largest fibre crop globally and is reaching almost 25 million tons production per annum (Table 1), accounting for almost 40% of the total textile fibre market. It is grown in many countries, but the majority of production is coming from China, USA, India, and Pakistan (see FAO statistics; ICAC; UNCTAD, ITC, WTO). Many sub-Saharan countries produce substantial quantities of cotton, but lack the local infrastructure and industry to produce quality export textiles for higher value addition. The global cotton fibre demand has shown a growth rate of more than 5% in the recent years, in line with the manmade fibre market expansion.

Other industrial natural fibres are produced in substantially smaller volumes, all together not exceeding 6 million tons production. These production volumes have stagnated in the last decades and these fibres are only supplying a few percents of the textile fibre market (2-3%) (FAO statistics).

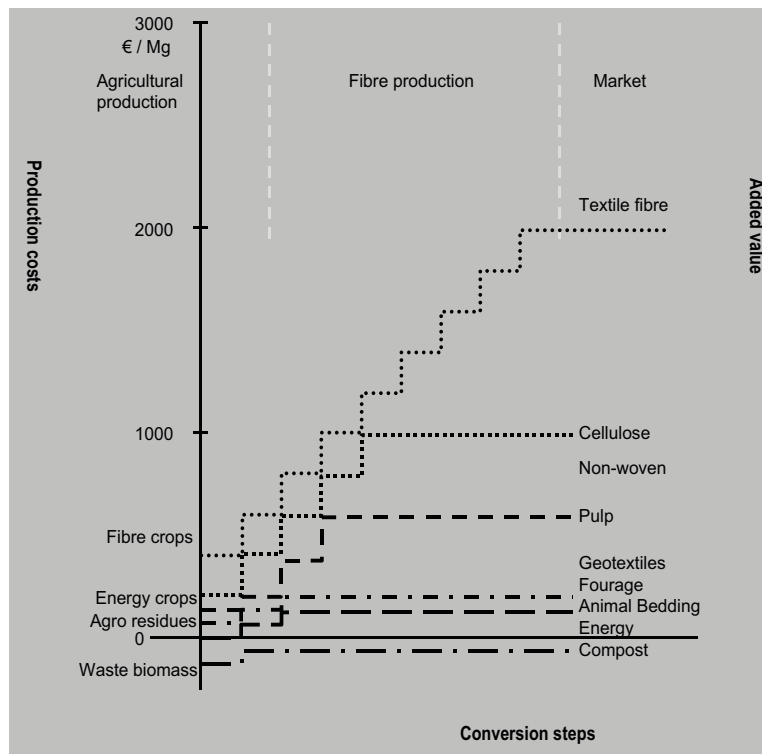
Trade markets and exports of most of the natural fibres (Sisal and Henequen, Jute and Kenaf, Flax and Hemp) have seen a decline in the past decades, which is often attributed to introduction of cheaper synthetic substitutes. The market for jute bags for transport of agricultural products, for example, has seen dramatic decline, also due to increased

Table 1 - Estimated global production volume averages of different natural fibres (in million metric tons per year average over the recent years).

	Mill. tonnes	Main producer countries
Cotton	25	China, USA, India, Pakistan
Kapok	0.03	Indonesia
Jute	2.5	India, Bangladesh
Kenaf	0.45	China, India, Thailand
Flax	0.50	China, France, Belgium, Belarus, Ukraine
Hemp	0.10	China ¹
Ramie	0.15	China
Abaca	0.10	Philippines, Equador
Sisal	0.30	Brazil, China, Tanzania, Kenya
Henequen	0.03	Mexico
Coir	0.45	India, Sri Lanka
Wool	2.2	Australia, China, New Zealand
Silk	0.10	China, India
Manmade cellulosic fibres	3.3	

¹ China has announced to substantially increase the hemp production for textiles in the coming years to 1.5 million tonnes of fibre per year

Fig. 1 - The relation between value addition and conversion steps in the fibre chain



container shipments. Agricultural twine and ropes is still one of the largest markets for especially sisal, while the highest fibre grades are used for manufacturing of rugs and home furnishing. Current innovation on the markets for natural fibre containing (composite) products has widened the scope of its use and that should go parallel with agro-industrial development. Then it has the potential to become a major sustainable bio-economic commodity.

The economic value of the fibre crop depends on its end-use market and costs of production. Fine and long fibres that can be spun into high counts of yarns are most appreciated and valued. On the other hand homogeneity is prerequisite to efficient processing and high quality end-products. Lower quality shorter or coarser fibres are converted into nonwoven products, paper pulp or other materials. The lowest value of fibres is when it is left in the field as mulch to compost. The value of the end-product is not always reflected in the benefits for the agricultural production, however. In the production chain from farm to customer many steps are taken (Fig. 1) and quality improvement is attained at the cost of substantial losses. By-products, residues and wastes commonly are not contributing to the value addition. On the contrary, these may cause environmental pollution or add to costs for disposal.

The environmental impact of natural fibres accordingly also relies on how by-product management is organized. In principle renewable resources will be fully bio-convertible and may be reutilised as source for carbon in the form of carbohydrates (sugars), lignin or protein (nitrogen) and minerals. Often agricultural production utilises only a small part of the total fixed carbon in the biomass produced or harvested. These wastes can be utilised far better. For example, only 2-4% of the harvested biomass of sisal is converted to economic value. The remains from the leaf contains short fibres and soluble sugars that are

Table 2 - Natural fibre major end-markets and by-products for value addition

Crop	Fibre Market	By-Product
Cotton	Textile fabric: apparel (60%)	Linter, cottonseed
	Home furnishing, upholstery	Stalks
	Non-wovens	
	Specialty paper	
	Cellulose	
	Medical and hygienic supplies (Hydrophilic absorbents)	
Kapok	Pillow, mattress	Seeds, wood
Jute and Kenaf	Hessian, sacking	Stalks (sticks)
	Carpet backing	
Ramie	Textile fabric	Leaves, stem
Flax & Hemp	Textile fabric	Seeds, shives
	Composites	
	Non-woven, insulation mats	
	Specialist paper	
Abaca	Speciality paper, tea bags	Leaves, juice
Sisal & henequen	Twine and ropes	Short fibre, juice, poles, stem
Coir	Twine, ropes, carpets, brushes, mattress	Copra, water, shell, pith
	geotextiles, horticultural products	Wood, leaves
Wool	Knitted wear	Lamb meat, cheese
Silk	Fine garments	Worms, cocoons
	Veils and handkerchiefs	Fruits, wood

now commonly discharged in the environment. Other plant parts (poles and stems) are left in the field or burned. Recently, studies have been initiated that are aiming at zero emission models for the sisal industries and to use this waste biomass for ethanol fermentation purposes or production of biogas. Additional income from carbon trade (CDM) promotes (foreign) investments in local environmental and socio-economic improvements.

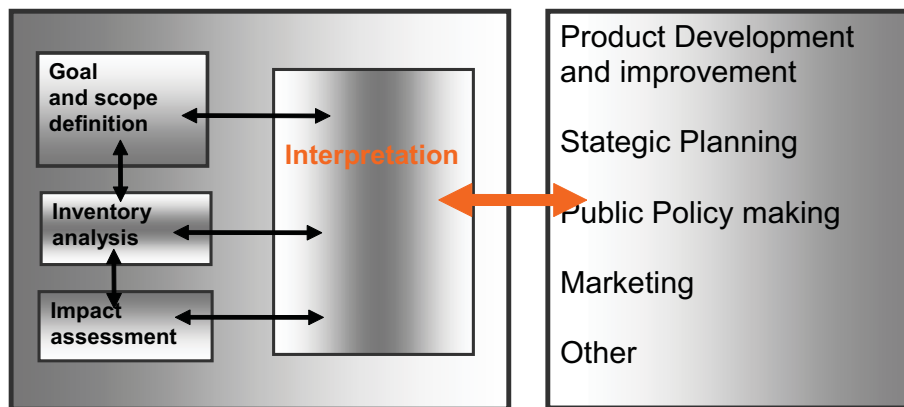
In bast fibre crops like flax, hemp and jute the yield of waste biomass per ha is relatively low. Approximately $\frac{1}{3}$ of the stem dry weight is the appreciated long fibre. The woody parts (shives, hurts, stick) may be applied as light weight construction materials or burnt as (cooking) fuel. During the transformation from straw to fabric yield losses are considerable (Fig. 3). Different grades of tow and short fibres are released during the scutching and hackling processes that are better suitable for staple fibre spinning and rope making, for non-wovens and fibre composites and in non-wood specialty paper pulp production.

Many fibre crops also yield valuable oil seeds as by-products (cotton, kapok, linseed, hemp), and many oilseed crops yield fibrous residues. For example coir is considered a by-product from the coconut oil and copra production. Also the wool market may not be the main value to the sheep farming.

LIFE CYCLE ASSESSMENT (LCA)

Comparison of the environmental impact of processes and products requires quantitative tools as criteria for the selection of the most sustainable option. Life Cycle Assessment (LCA) of products and processes is such method that was developed in the early 1980s. The environmental impact and the ecological implications of the entire life cycle of a

Fig 2 - LCA quantitative environmental impact framework



product are systematically classified and quantified from primary raw material production to processing and to final product disposal. LCA methodologies are composed of five stages (Fig. 2) :

- **Goal definition** establishing the aim and scope of the study and defining the function, as well as the functional unit of the product under examination.
- **Inventory** formulation that comprises of the analysis and listing of polluting emissions, the consumption of resources and energy per functional unit and the determination of the environmental intervention.
- **Classification** that includes the categorisation of the environmental interventions in a number of environmental classes and the formulation of environmental profiles for each class that often can be reflected in numerical values.
- **Interpretation** that comprises of the analysis of the results and the estimation of the related uncertainties.

The methodology for impact assessment is widely accepted and ISO standards have been established to compare and quantify the various weighing factors. The assessment consists of weighing the classes to integrate the environmental profiles such as effects on greenhouse gas emission, ozone depletion, acidification or eutrophication. It is however unrealistic to desire unification into one environmental impact number for widely diverse ecological and economical effects.

Difficulties in defining the system limits and in the collection of data, as well as measurement errors may hinder the conduct of LCA and result to misinterpretation of the environmental impacts. Careful objective inventory analysis (Fig. 2) of the various impact weighing factors and inventories of components can be made, but weighing against competing economic products is always at stake. The goal and scope of the LCA may affect the outcome to a certain extend. The goal can be either for product development and improvement, strategic planning, or public policy making, marketing or other. In advance definition of criteria and the weighing factors for emissions and consumption of resources is essential for determination of eco-indicators.

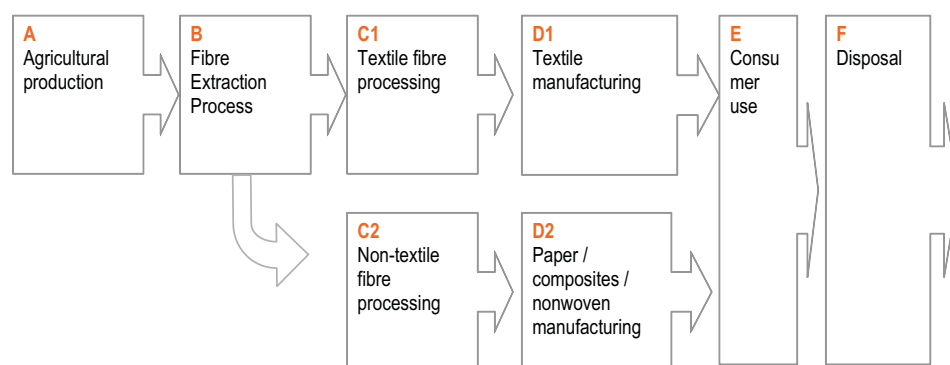
The ecological footprint is another well known method to compare and express the impact on the environment (Rees and Wackernagel 1994). The footprint is expressed in land area required per person to maintain his life style (including food, energy, water, travel, housing clothing etc.). To fulfil all the human needs, it is estimated that an area of 0.01 à 0.02 km²

per person is required. The difference per capita of average footprint is strikingly different per country and directly linked to the consumption pattern and economic development. According to WWF and other NGO's the human footprint is approaching or even exceeding the available supply of natural resources or the planet's biocapacity. The increasing public awareness and concern about global warming and its consequences is now receiving broad political support. Many governments take measures to stimulate sustainable development and promote better use of available resources. One example of such a new approach towards the use of resources is the "cradle to cradle" (C2C) philosophy. A lot of positive response has been created by the C2C concepts of McDonough and Braungart, that are strongly focussed on the better design of products and full reuse of materials after disposal. Eco-effective design of products requires reuse of waste to make new products. The suggestion is made that limitless economic growth can be obtained when the resources are properly reused (without quality loss). This is disputable because the costs of recycling and upgrading are not taken into account. When the system boundaries are taken too wide – like critical observers recognise in the C2C approach – more uncertainties are created and room is left for discussions about measures to be taken for necessary ecological improvement. However, the moment seems right for ecological improvements that can be shared under this C2C umbrella. It inspires at least many governments and industries to rethink and to find alternatives for the way we make things. Our waste becomes the food for the next generations in everlasting consumer cycles?

FIBRE QUALITY CHAIN

Determination of the LCA framework includes the inventory environmental impact of the various stages of the production chain. In the next paragraphs the environmental and sustainability issues that play a role in the different stages (Fig 3 A-F) of natural fibre production and use are discussed. These are including the input – output of energy or chemicals and a total mass balance of main product, by-products or residues and wastes. The production chain for fibre crops can be divided into three main links: agricultural production – fibre processing – and utilisation (Fig. 3).

Fig 3 - Agro-industrial chains of fibre crop production, processing and application



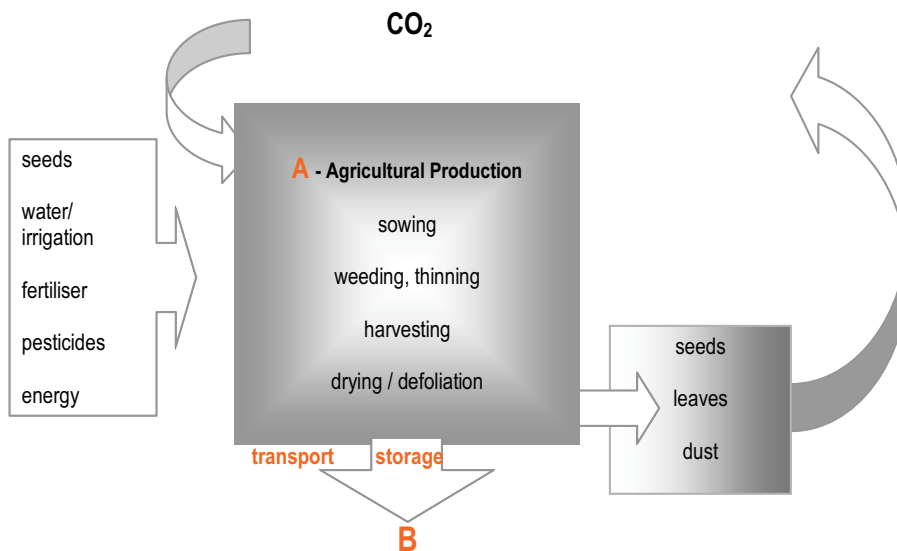
A - Agricultural Production

Breeding cultivation	Genetics for yield and quality improvement
Cultivation	Agronomy: soil, climate, weed, disease and pest control, fertilizers
Harvest/storage	Moment of harvest, mechanization, storage conditions, transport and handling

Since primary production is paid for quantity rather than quality, the breeding is often focussed on yield improvement and disease resistance. Concerns about the safety of genetically modified organisms or GMO-crops has resulted in fierce political discussions. The commercialisation of Bt cotton attracted reactions from environmentalists, although its use claims substantial reduction in the need for polluting pesticides. Their objections against GMO are the loss of biodiversity and uncertainty of risks of spreading potential harmful genes in the ecosystem.

Growing of crops results in the fixation in biomass of atmospheric CO₂ through photosynthesis and has therefore in principle a positive effect on the CO₂ balance. In the primary cultivation of fibre crops (Fig 4) the input of fertilizers, and agrochemicals for crop protection and disease control are well known factors that negatively contribute to the overall picture of the ecological friendliness of crop production. In addition the degree of mechanisation of soil preparation, sowing, weeding and harvesting adds substantially to the impact, due to the fossil fuel consumption. Several studies have calculated these in detail for especially energy crop production. For some fibre crops these calculations are made and compared with products such as synthetic alternatives. The production of fibre crops has varying impact on the environment, as far as the requirements for fertiliser and pesticides and energy are concerned. In general, the fibre crops under examination are found to have moderate requirements for fertiliser and crop protection chemicals, whilst energy requirements can be thought of as very small due to the extensive farm structure and the relative importance of labour in traditional farming systems. Consequently, the production of fibre crops has a limited impact on the environment.

Fig 4 A - Agricultural production inputs and outputs



B C D - Fibre Processing

Fibre extraction	Ginning/retting, braking, decortication, degumming
Fibre preparation	Cleaning, hackling, carding, refining, extrusion, steam explosion, chemical/biochemical treatments, etc

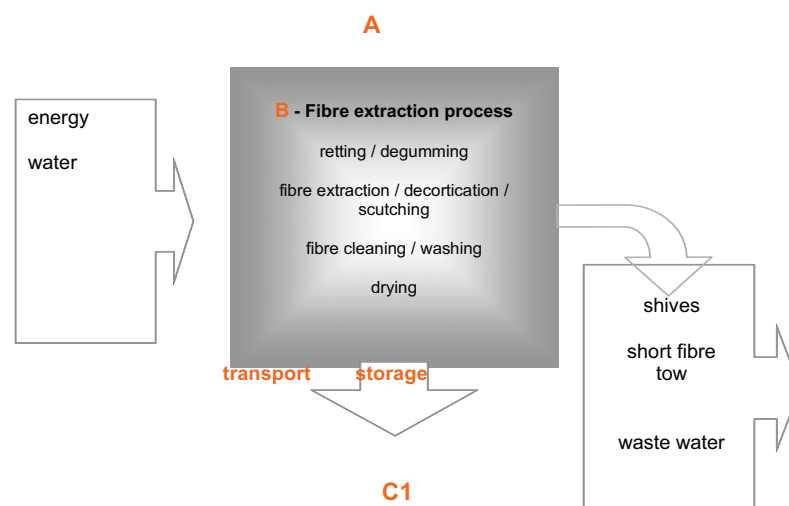
In the complex sequence (Fig.3) of fibre extraction **B** and manufacturing of half-products **C** and conversion to trade ware **D** different numbers of steps are required for each end-product with input of machines, energy and other resources or processing aids such as water, chemicals (dyes, surfactants, fire retardants or other additives), microorganisms, or enzymes. These are potential sources of pollutants of the environment when ignorant management and irresponsible disposal takes place. The fibre extraction process **B** consumes fossil energy and water, generates biomass waste and contaminates process water, thus presenting a considerable risk of pollution of surface waters, when no measures are taken for waste water treatment. Utilisation of residues and waste for generation of energy, or other value added outlets substantially enhances the overall ecological performance of a fibre crop.

Restricted quantitative information on input and output costs is available from industrial fibre production chains. Small holder industries often cannot afford to invest in waste treatment or are even still unconscious about the harm it may cause on the long run. For the large industries, taking the lead in responsible entrepreneurship and consequently a keen interest in improved ecological performance and sustainable supplies of bio-based resources, up-stream quality control includes investment in the ecological performance of their suppliers. Obsolete methods of fibre extraction and fibre processing not only can be a source for pollution, but also affect labour conditions of workers.

In general, comparative studies on the production phase of fibre crops with synthetic products, or glass fibres, indicate that fibre crops provide environmental benefits in terms of reduced CO₂ and greenhouse gas emission levels and consumption of fossil energy.

Most common natural fibre textiles for clothing are produced from cotton or to a lesser extend from other fibres such as flax linen yarns, silk and wool. The sequence of fibre preparation for spinning and weaving and finishing comprises a number of processes that

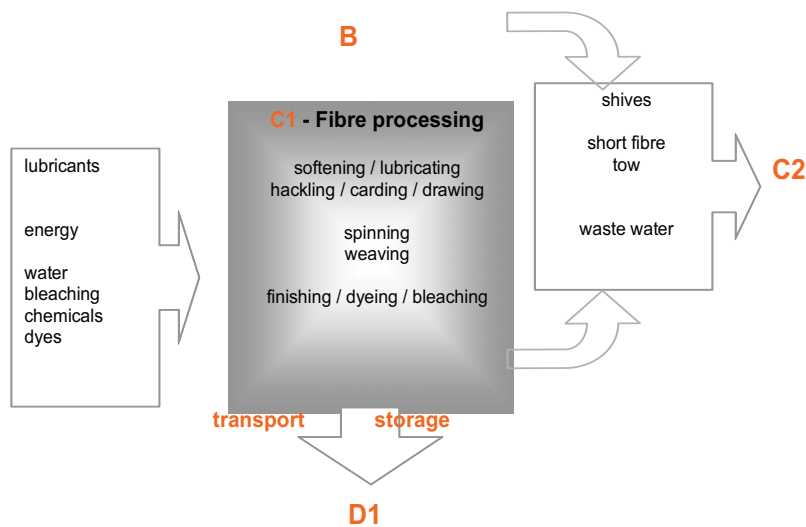
Fig 5 - **B** - Fibre extraction inputs and outputs



C-1/D-1 - Textile production

Fibre processing	Spinning, weaving, dyeing, printing, finishing
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Fig 6 - C1 - Textile fibre processing inputs and outputs



require energy and chemical additives, and process water. Textiles nowadays are often produced from blended yarns (with synthetic or other natural yarns) to improve the wear comfort or appearance of the end product (gloss, elasticity). Traditional hemp textiles were too coarse for apparel, but improved techniques allow production of lighter and softer texture and enhance its utility. Similarly the jute fibre applications are far extended beyond the traditional jute bags used for packing of agricultural products.

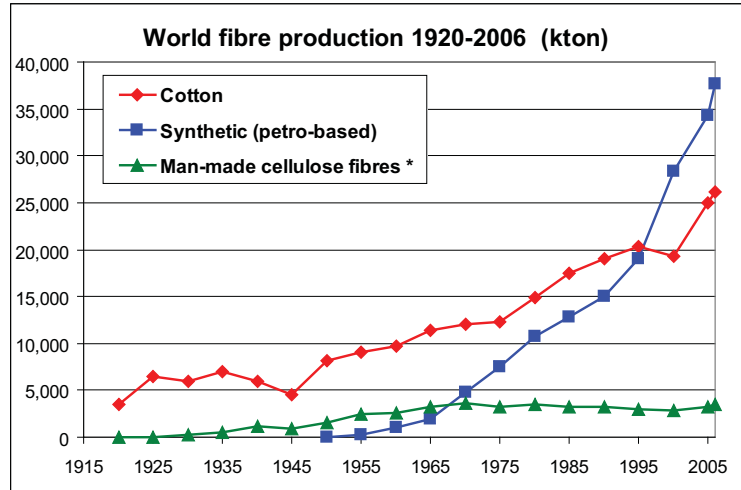
World fibre production volumes for textiles is strongly increasing (ever since mid 20th century with upcoming competition from petrochemical based fibres) for both cotton and manmade fibres (Fig.7). The textile markets for regenerated cellulose and cellulose derivatives remain at a modest levels. The classical process of manufacturing viscose may use different sources of cellulose derived from wood pulp, cotton linters or bamboo pulp. The heavy pollution this process caused in the past has been eliminated almost completely, due to chemical recovery. But energy and chemical consumption still are considerable.

Environmental concerns have successfully banned the most toxic chemicals that were in use in the past for textile dyeing and bleaching and new standards have been designed for risk avoidance and prevention along the entire textile manufacturing chain.

The natural fibres that are used for non-textile applications can be grown on purpose for this market (e.g. Abaca for specialty paper) or the cheaper lower quality fibres unsuitable for textile processing may find a niche outlet in paper making, composites or nonwoven manufacturing. Many novel end-uses for cellulosic fibres have been identified and many have been demonstrated to be technically feasible or have already entered the market.

The lower qualities of fibre (tow, straw), which are produced as residue from agro-industrial production have to compete with highly efficiently organized and therefore relatively cheap wood fibre on the market for paper and pulp, fibre board and composites. Both hard- and softwood fibres are utilised on large scales for refining and pulping. Only about 7% of the world's virgin cellulose pulp is made from non-wood sources (mainly straw, bagasse, and bamboo) (Table 3). In the EU, US and Canada paper industries practically only wood pulp is currently used.

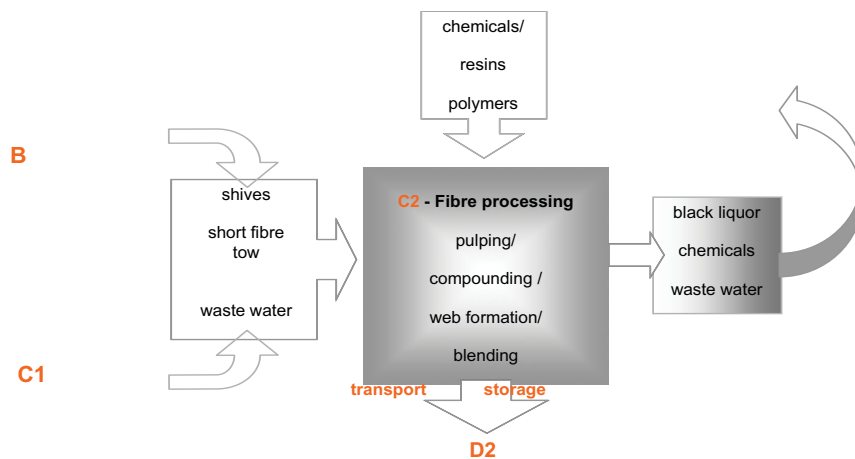
Fig 7. – World textile fibre production volumes over the last century (source IVE 2007)



Compared to wood based pulping natural fibre pulping processes for the production of paper, board and cellulosic fibre products is, in general, ecologically advantageous due to the lower energy and chemicals requirements. However, chemical recovery for small scale pulping is economically unattractive and, therefore, pulping of fibre crops, such as bamboo, jute, kenaf, abaca and hemp often causes severe pollution requiring integrated waste water control.

The major fibre sources for non-wood pulping are cotton linter, rice and wheat straws and bamboo.

Fig 8 - C2 - Non-textile fibre processing inputs and outputs

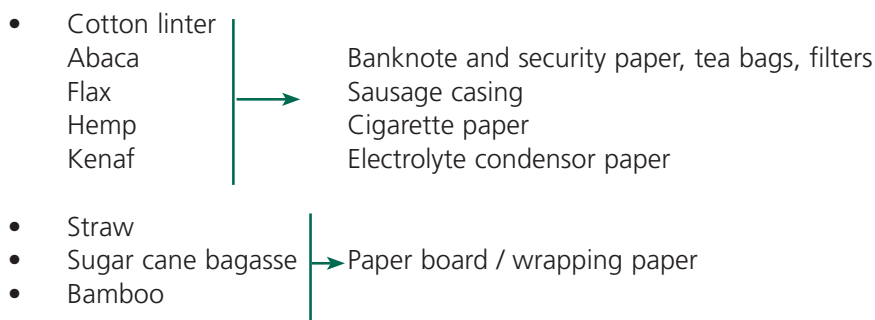


C-2/D-2 - Non-textile end-use

Fibre processing Pulping, refining, compounding, moulding

Table 3 - Global non-wood paper pulp production capacity (FAO)

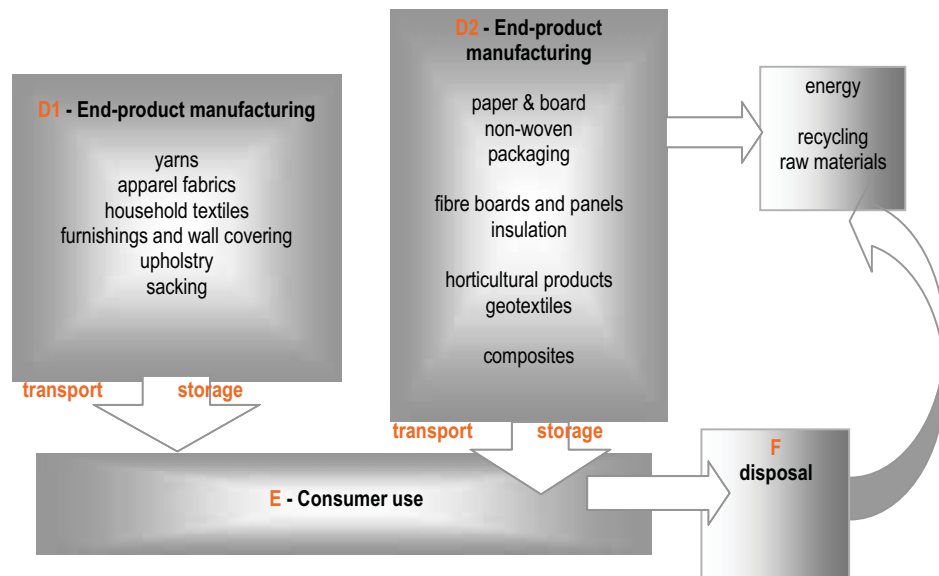
Country	Capacity (million tonnes)	% of total
China	15.2	71
India	2.0	9
Mexico	0.3	1
Peru	0.3	1
Philippines	0.3	1
Indonesia	0.3	1
USA	0.2	1
Thailand	0.2	1
Colombia	0.2	1
Brazil	0.2	1
10- Country Total	19.2	90
Total World	21.3	100 (<7% total pulp)



Other non-textile markets for natural fibres (table 2) are found in fibre composites, where substitution of mineral fibres (asbestos, glass fibre) has been demonstrated to be feasible. In fibre cement and fibre reinforced polymer composites or fibre boards numerous products can be fabricated for building or automotive applications. Coir and jute fibres have demonstrated their value in biodegradable geotextiles for erosion control and ecological sustainable solutions in civil engineering.

The low-end market outlet for fibrous biomass is found in energy production (Fig. 1). Its heating value is the base-line value for economic conversion. Due to the emerging bio-based economy worldwide governmental promotion of renewable energy and biomass conversion plants is targeting for a substantial contribution to the energy production over the next 10 years. The 2nd generation bio-fuels based on conversion of lignocellulose feedstock into ethanol, pyrolysis oil or biogas is investigated all over. Since biomass utilisation for energy production is still expensive, compared to fossil energy sources, the so called biorefinery principle is considered. Combined fibre extraction and energy production may increase the revenues.

For many of the products made from natural fibres a substantial contribution to the complete life cycle (or cradle to grave) impact is attributed to the utilisation and disposal phases. Comparison with non-renewable alternatives is then relevant. Cotton requires less fossil resources in its production phase (e.g. energy, fertilizer, pesticides) than synthetic polyester but higher demand for water. No dramatic differences of the environmental impacts in textile processing (dyeing and bleaching) can be observed, but in general

Fig 9 - **D E F** - End products manufacturing and use inputs and outputs

E F - Utilisation

Use	Performance
Disposal	Reuse and recycling, incineration / degradation

synthetic or blended fabrics show a longer functional life time. On the other hand in the utilisation phase the lower energy requirement in laundering for synthetic textiles can be an argument. The consumer's perception of wear comfort and garment appearance often are more decisive for purchasing. The environmental costs of an attractive product commonly then are of lower priority.

The use of natural fibre based geotextiles in civil engineering offers large environmental advantages by the fact that these are fully biodegradable and no synthetic polymers remain in the soil after its functional lifetime. Similarly, in agriculture and horticulture the use of natural fibre based twine or nonwoven mats, planting pots etc., do not require removal since they are compostable, which improves even the soil structure.

In the automotive industry the use of cellulosic fibres as renewable raw material in fibre reinforced composite materials has received much attention as "green" development and is showing much promise. Since its introduction a decade ago the use of natural fibres in automobiles has shown increasing trends. Among those, flax and hemp non-woven find a growing outlet in compression moulded trim panels and dashboards. The natural fibre reinforced injection moulded composite parts show less demands on the fibre processing and handling (as compared to textile fibre production). The biggest LCA advantage over glass fibre reinforced composites is the weight reduction resulting in lower fuel consumption in the use phase. Other advantages are the lower wear of equipment in the production phase and easier end-of-life recycling by incineration.

Another potential large market for ligno-cellulosic materials is found in an increased interest for renewable materials in ecological building and construction applications. For

example, it has been demonstrated that high performance / high quality fibre boards can be manufactured from the whole fibrous coconut husk without the use of any chemical additive. The global demand for building materials and timber is ever increasing and with rising prices of wood the market for sustainable timber substitutes seems bright. Coconuts are abundantly available in the poorest regions and their husks now often discarded because of lack of economic value. Manufacturing of ecologically and (bio-)economically sustainable materials from this waste could create many jobs and offer new perspective for local industrial development.

The introduction of novel products on this scattered and conservative market of building materials is difficult. This is due to complex building regulations and standardisation in the different EU member states, combined with traditions and different legislation on the use of building materials. Implementation of alternative renewable building products at large scale involves substantial commercial challenges that should be the driving force behind development of the production chain. This can only be achieved when the qualitative and quantitative aspects have been defined in detail for each specific end-use. It should be substantiated that especially in the case of building materials, the ecological advantages should combine with better comfort, health and safety aspects (indoor climate), without premature degradation or excessive maintenance costs or the need for hazardous chemicals for preservation.

RESEARCH AGENDA

The present review of the environmental impact of natural fibre production and industrial applications highlights the need to comprehensively evaluate the environmental benefits that emanate from the use of fibres, as well as the possibility of utilising the existing research results for promoting natural fibres.

Firstly, numerous unexplored areas can be identified for research, such as in the case of building materials, where comparisons of LCAs need to be undertaken, taking into consideration the costs of maintenance and replacement in relation to the performance of the material. In other areas, as in the case of horticultural production inputs, where data on their contribution to the environment is not available, LCA could be used to promote fibre based products. Other fields of research may include improvement of the fibre and cellulose extraction process from fibre crops (sisal, abaca), underutilised crops (bamboo) and crop residues (straw, bagasse) and waste control, novel fibre production processes and applications and the production of natural binders (lignin) and coatings (wax) such as for the manufacturing of boards from coir husks.

Secondly, existing research results may be utilised in order to promote applications of natural fibres. For example, nursery products, such as biodegradable flower pots may consist of a promising area for growth, given the necessary promotion. More generally, the packaging sector, in view of the stringent EU regulations, may provide a niche market for natural fibres.

DISCUSSION AND CONCLUSIONS

The politics for changing to a bio-based economy requires substitution of common raw materials, that are currently largely produced from fossil (petrochemical) or mineral resources, by products produced from renewable (plant and animal based) resources. On ecological grounds products like natural fibres should then be preferred that are based on short rotation photosynthetic CO₂ fixation. Therefore, competitive products based on renewable resources need to be developed that have high quality, show excellent technical

performance and harm the environment less than current products based on petrochemical materials.

Ecological impact assessments are complex and often use incomparable weighing factors. The impact of primary agricultural production of fibre crops on the total LCA varies strongly per crop and depends on levels of mechanisation and use of agro-chemicals. Overall ecological performance of a crop improves when residues and by-products are better utilised.

By-product utilisation and installation of waste water treatment systems (biorefinery, whole crop utilisation) substantially contributes to an enhanced sustainability of (fibre) crop production chains.

In the production phase the score of fibre crops on CO₂ and greenhouse gas emission levels, fossil energy consumption and resources is much better than for competing petrochemical products. The effects of technical modernisation of production systems on the total LCA of fibre products need to be balanced with economical competitiveness and social aspects of labour provision. Rural agro-industrial developments counteracts urbanisation.

The impact of synthetic resins, additives and polymers on the LCA is large in blended textiles or non-wovens and composite materials. In many cases also the utilisation and disposal phase contributes substantially to the overall impact. Quantified LCA's for the various application areas of fibre crops should lead to well-founded systems for eco-labeling and certification of the best practices.

The environment has become a major driver for industries and governments. The time seems right for eco-effective design as promoted in the 'cradle to cradle' (C2C) concept. This has evoked a lot of response from industries who are seeking more eco-efficient production and sustainable commerce. The growing competition for renewable resources for energy and products will also open new possibilities for exploitation in biorefineries of biomass from agro-industrial residues for production of energy, bio-gas and electricity, but also many other products like animal feed and organic soil improver, constructive building products and composite materials, or even textiles or pharmaceuticals. Natural fibres and their by-products will play a central role here. Natural fibres are a major renewable (CO₂ neutral) resource for bio-based economical developments.

The competing claims for biomass resources gives increasing concerns about food supply security, land use and effects on deforestation and rural development. Fibre crops compete with food crops for land, water and nutrients on profit base. When the crop value sustains the farmers according to fair trade principles this does not cause problems. But, there is need for development of technologies to suit the scales of production possible in developing countries and LDC's. R&D strategic research agendas need to be implemented that make technology transfer possible. Promising tools and methods need to be demonstrated in practical situations.

There is not one strategy to achieve the various targets for enhanced use of natural fibres. Each individual crop and product demands a systematic approach. Sophisticated combination of resources and processes are leading to sustainable energy supplies and defined value added products.

Certification of the sustainability of the production chains for biomass energy and products is needed. International "commodification" of the multipurpose biomass for energy production and non-food applications requires international attention with respect to

competing claims for land use and biodiversity issues. Responsibility for sustainable imports and exports of bio-based goods lies with the governments.

The ecological impact of a product is not yet an important marketing issue. As long as the use of non-renewable products is not restricted by legislation or extreme costs fibre crops will be applied in the market niche where the best price / performance can be found. The specific performance of a product and cost reduction are still the major drives for a competitive market introduction. The appeal of natural fibre products should primarily be its quality.

Jute in South Asia

*A K M Rezaur Rahman, former International Jute Organisation, Bangladesh**

INTRODUCTION

Jute is a product of South Asia and specifically a product of India and Bangladesh. Nearly 98% of world jute is grown in these two south Asian countries. Nepal is the other country of south Asia that grows jute but its production volume is not very significant. Another south Asian country, Pakistan, does not produce jute but processes and manufactures a good quantity of jute goods through import of raw jute fibre mainly from Bangladesh. The table in the slide shows that recent average total world production of jute is of the order of 2465 thousand tonnes a year of which more than 2423 thousand tonnes are grown in the south Asian countries.

Table 1 - World production of jute

	Average of 4 years 2001/02-2004/05	%
<i>In thousand tonnes</i>		
World	2 465	100
India	1 533	62.19
Bangladesh	872.75	35.4
Nepal	16.83	0.61
India, Bangladesh & Nepal	2 423	98.2

Compiled from FAO Statistics (2001/02-2004-05)

There are some jute-like fibres such as Kenaf or Mesta the total world production of which is about 400,000 tonnes a year. The south Asian countries produce about 160,000 tonnes of those fibres.

Many people may have heard the name of jute but have not seen it. Jute is a gift of Nature, a fibre derived from a plant that we, in South Asia, fondly call the 'golden fibre' on account of its colour and that it earns much needed foreign currency for the country.

Jute sticks are used as fuelling and fencing materials in the rural areas of jute producing countries. These are good substitute for forest wood and bamboo for production of particle boards, pulp and paper.

Cultivation of jute is quite arduous and painstaking. It has a number of stages of processing namely preparing the land, sowing, weeding, harvesting, retting, extraction of fibre, washing, cleaning and drying etc. It's a yearly crop and takes about 120 days (April/May-July/August) to complete the process of cultivation.

JUTE PRODUCTS AND THEIR USES

Jute is a versatile fibre. It can be used independently as well as in blend with other fibres and materials such as plastics. The major manufactured products from jute fibre are: Yarn and Twine, Sacking, Hessian and Diversified jute products.



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Jute is spun into yarns and twines of various counts. Heavy and coarse yarns/twines are used as ropes/cords and for weaving cloths for sacks and gunny bags. Lighter yarns are used for weaving Hessian cloth and the lightest and finest yarns are used in carpet manufacturing industries and for production of fabrics suited for value added diversified jute goods.

Sacking and gunny bags are the major traditional jute products. These are used for packaging agricultural and industrial commodities like, rice, wheat, vegetables, corn, beans, cement and fertilizer etc. Sacking consumes more than 50% of the total production of jute fibre.

Hessian is jute cloth which has many uses, including as: carpet backing cloth, packaging material for cement and fertilizer industries and wrapping material for other fibres such as cotton and wool, seasoning and insulation materials for construction industries, soil saving and erosion control materials and as fabrics for diversified jute products like home textiles and shopping bags etc.

Diversified jute products (DJPs) are an array of non-traditional goods produced by transforming jute to numerous value-added products through innovations and application of artistic skills. Let us see pictures of some of the DJPs below. Catalogues of diversified jute products produced by National Centre for Jute Diversification (NCJD) of India and that of Jute Diversification Promotion Centre (JDPC) of Bangladesh can be viewed in the website of the International Jute Study Group (IJSG) www.jute.org.

That use of DJPs account for hardly 10% of total jute fibre consumption. This segment of the jute industry is scattered and decentralized and is composed of mainly SME entrepreneurs. They do not have enough resources; skills and expertise to enter into international markets with their products. They need support and assistance in the areas of product development, design and marketing etc. The support of the UNDP to the Government of India a few years back in this regard is worth mentioning. The CFC, the co-sponsor of this symposium is financing a project for development of entrepreneurship of DJPs through the IJSG. More needs to be done to promote diversified jute products along with traditional use of jute.

BENEFITS AND ADVANTAGES OF JUTE AND JUTE GOODS

- The young tender leaves of jute plants are eaten as vegetables;
- Jute cultivation, according to jute scientists, enriches the fertility of the soil for the next crop;
- The lush green jute plants help protect environment and maintain ecological balance by providing much needed oxygen to the atmosphere;
- Jute and jute goods are bio-degradable and re-usable.
- The production process of jute goods is simple and unlike synthetics it does not involve use of harmful chemicals;
- Jute bags preserve the quality of dry food items like rice and wheat as air can pass through jute bags easily. Jute bags are safe for storage purposes. They are stable and do not slide down when stacked. Jute bags are also easy to handle both manually and mechanically;
- According to jute scientists, geo-jute cloth is useful substitute for synthetic geotextiles for construction of roads and embankments, soil saving and erosion control measures; it reportedly absorbs heat and keeps the earth cool;

SOCIO-ECONOMIC IMPORTANCE & IMPLICATIONS OF JUTE FOR THE SOUTH ASIAN COUNTRIES

Jute cultivation is a matter of culture to the marginal farmers of Bengal part of the Indian sub-continent, the territory now constituting Bangladesh and the West Bengal province of India. The climate and soil of the area are especially suitable for jute cultivation. Historical facts suggest that jute cultivation and production of jute goods have been going on in this part of south Asia from ancient times.

Jute is a cash crop for millions of poor and marginal farm families of the south Asian countries. Even though the cultivation process of jute runs for four months of a year, jute related activities such as transportation, trading, industrial processing and production of diversified jute goods continue round the year. Tens and thousands of people, considerable portion of which are women, are engaged in these activities. They derive their income from these activities and maintain their livelihood.

The jute economy impacts on social and economic development and plays a vital role in reducing poverty and hunger. Jute harvesting takes place at a time when marginal farmers and workers are faced with shortage of their food stocks. The cash derived from sales of jute fibre and the wages received by workers are an important contribution to food security for this vulnerable segment of the population.

The socio-economic importance and implications of jute can be better understood from the obtaining situation of the jute sectors of the south Asian countries as presented in the following table:

Table 1 - Jute sectors of South Asian countries at a glance

SL	Item	India	Bangladesh	Nepal	Pakistan
Average of last 4 years					
1	Jute cultivation area	900 000 ha	450 000 ha	12 000 ha	0
2	Production of fibre	1 533 000	872 750	16 830	0
3	No of jute mills	77	145	6	10
4	Workforce	4.6 mill	2.5 mill	50 000	20 000
5	Production of jute goods	1 600 000 mt	500 000 mt	16 000 mt	129 000 mt
6	Export of jute goods	286 000 mt	450 000 mt	10 000 mt	13 500 mt
7	Export of raw jute	0	400 000 mt	0	0
8	Internal use	82%	18%	37%	75%
9	Export earnings	US\$ 270 m	US\$ 400 m	US\$ 10 m	US\$ 14 m

Compiled from Statistics and data collected from FAO and concerned organizations of jute producing countries

We find from the statement that:

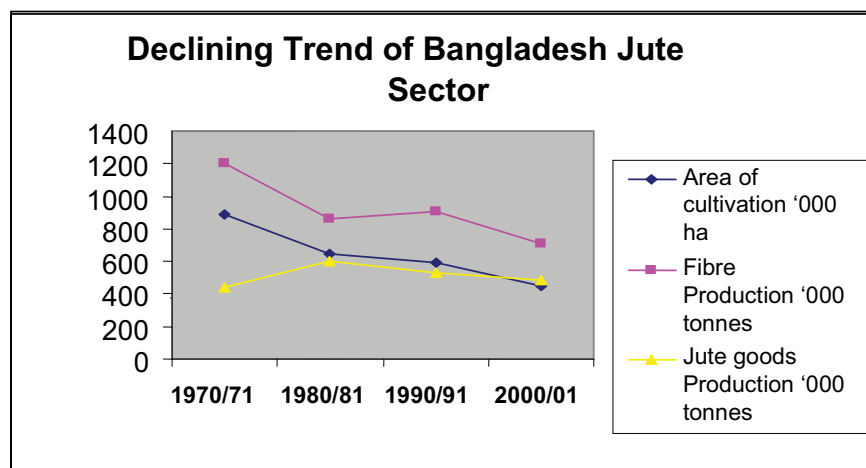
- a. India is the largest jute producing, manufacturing and consuming country; it has about one million hectares of land under jute cultivation and produces 1.6 million tonnes of jute and jute goods annually.
- b. The size of the Bangladesh jute sector is half of that of India's; it is the only jute fibre exporting country.

- c. The jute sectors of Nepal and Pakistan are not big as that of India and Bangladesh but have important contribution in employment generation and income earnings of poor farmers and industrial workers;
- d. More than 70% of the jute goods produced in south Asian countries are used by themselves;
- e. About 7 million people of the south Asian countries are directly involved in jute related activities;
- f. The jute producing countries earn a substantial amount of foreign currency from export of jute goods and jute fibre.

Jute was the principal packaging material for global agricultural produces a few decades back. It was the major export earning commodity of the poor jute producing countries like Bangladesh. World population has increased and so also has increased many folds the production of global agricultural and industrial produces but demand for jute packaging materials has not increased but declined. Current world cereal production is estimated by FAO as 2180 million tonnes this year (2008). I have made a rough calculation that 43.6 million tonnes of jute bags of 1 kg weight each would be needed to pack the total quantity of the above mentioned cereal products. If only 5% of the world cereal commodities are packaged in jute bags the jute industry and the jute economy will find its way to regain its lost position easily. That will consume more than 2 million tonnes of jute bags alone in the backdrop of current production and consumption of some 1.2 million tonnes of jute sacks a year. In fact the rejuvenation of jute economy and the welfare of the producers and consumers of jute lie in wider use of jute as packaging material for such goods which have implications on health and environment.

Bangladesh jute industry, which grew up on export orientation, has been hard hit at declining demand of jute packaging materials in the international market. The composite segment of its jute industry which produces traditional jute packaging materials such as sacking and Hessian cloth has suffered tremendously on account of this reason. More than 50% of this segment's installed capacity is now idle. During the early 1990s this segment used to produce 450,000 tonnes of jute goods. It now produces hardly 200,000 tonnes. Incidences of closure and under utilisation of installed capacities of jute mills have

Figure 1 - Jute sectors of South Asian countries at a glance



happened at random in Bangladesh. The country's, for that matter the world's largest jute mill, Adamjee Jute Mills, which used to employ more than 20,000 workers, has been closed down. More such mills are being either shut down or laid off resulting in loss of jobs, labour unrest and social security problems. The sliding trend of the Bangladesh jute sector may be visualised from the following chart:

India has, however, averted such a situation and tackled it through offering minimum price support to the farmers and introducing compulsory use of jute goods for packaging of its huge domestic agricultural produces.

There has been hardly any investment for technology development in the jute sector except some innovations in respect of diversified uses of jute. Those innovations, however, have largely remained in the laboratory of the research institutions for lack of support for commercialisation. As more than 70% of jute and jute products are used in the south Asian countries and India in particular, the image of jute remains a 'regional' commodity and hence it has not attracted much global attention for research and development.

CONCLUSIONS

Jute continues to be an important commodity for employment and source of income of millions of poor people of the producing countries of south Asia. Jute deserves international support and cooperation as a natural corollary to the United Nations' Sustainable Development Programme and Millennium Development Goals for socio-economic development, protection of environment and reduction of poverty. Jute was an important item for international trade and it still remains the preferred packaging material. As many as 45 and 62 countries of the world imports jute fibre and jute goods respectively from south Asian countries on account of its bio-degradable and environment friendly characteristics. There is no need to undertake any big project to salvage jute from its present difficult situation. The benefits of jute should be marketed more robustly to create demands for jute goods worldwide. In that event, the jute industry will itself take necessary corrective measures. In the meantime the following catalyst role may be played by the international community and the stakeholders of the natural fibres as the case may be:

- member countries of the UN system should be encouraged to adopt appropriate policies for use of jute products instead of synthetic substitutes in packaging cereal commodities in particular;
- super markets and shopping outlets worldwide should be encouraged to use jute shopping bags instead of polythene/polypropylene shopping bags;
- geo-jute and jute geo-textiles should be used instead of synthetic alternatives in construction of roads and pavements, soil saving and erosion control activities etc.
- entrepreneurs may be encouraged for using jute as basic raw material for pulp and paper manufacturing industries and
- finally and importantly, there should be coordination and understanding among the stakeholders of the various natural fibres with regard to better utilisation of these God gifted commodities for the humanity in liaison with each other.

The resolution by the UNGA to hold the IYNF in 2009 is a welcome and timely step to create awareness and to remind the international community of the many advantages of natural products over man-made alternatives. But mere propagation of the advantages and disadvantages of using natural fibres and artificial synthetic alternatives respectively will not suffice as business does not care for rhetoric and words of idealism. The UN member countries should be encouraged to adopt appropriate policies and enact laws to use more natural fibres instead of synthetic fibres. The international community is urged to take steps in this regard.

Cotton in West and Central Africa: Role in the regional economy & livelihoods and potential to add value

Karim Hussein¹, IFAD, Rome

INTRODUCTION

This paper provided the basis for a presentation made at the FAO Natural Fibres Symposium held in Rome on 20 October 2008. It draws on work carried out at the Sahel and West Africa Club/OECD² supplemented by research and analysis on developments since 2005, particularly concerning potential for processing and textiles industry development in the West and Central Africa region (WCA). These new elements were compiled in collaboration with Leonidas Hitimana (Agriculture Unit, Sahel and West Africa Club, OECD) and Kristen Cain (consultant, IFAD)³.

This paper takes a sub-Saharan Africa (SSA) perspective, focusing on generating the maximum poverty reduction and income earning potential from one key natural fibre that is one of the oldest fibres cultivated and processed into cloth by humanity: cotton. Cotton has also been central to poor producer livelihoods and a significant number of WCA national economies for many decades. Indeed, there is evidence to indicate that the original West African and Sahelian variety of cotton (*G. herbaceum*) was the major fibre crop type domesticated by humans for agricultural production and use in the region for hundreds of years from ancient times.

The paper begins by summarising the regional and rural livelihoods context and the importance of cotton production and trade in West and Central Africa. It then addresses the potential and challenges for developing processing capacities and the textiles industry in WCA, providing examples of potential demand and markets. Lastly, the paper highlights a number of strategic issues for maximising the value-added that can be drawn from cotton production and trade in WCA, increasing the contribution of cotton to promoting regional development, improving livelihoods and reducing poverty in WCA.

REGIONAL CONTEXT

According to the most recent World Bank data (World Development Report 2008), over 380 million people live on less than US\$ 1.25 a day in SSA. Of the 550 million people living in 24 countries of WCA from Mauritania, Mali, Niger and Chad in the North down to Gabon and

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2 K.Hussein, L.Hitimana and C.Perret, 2005, Cotton in West Africa – The Economic and Social Stakes, The Development Dimension series, OECD, Paris. See also: (i) K.Hussein, L.Hitimana and C.Perret, 2005, Consultation on the Cotton Crisis in West and Central Africa: Timeline of Key Events 2001-2005, Sahel and West Africa Club/OECD, Paris. SAH/D(2005)553, September (ii) K.Hussein, C.Perret and L.Hitimana 2005, Economic and Social Importance of Cotton in West Africa: Role of Cotton in Regional Development, Trade and Livelihoods, Sahel and West Africa Club/OECD, Paris. SAH/D(2005)556, November.

3 I am grateful for inputs provided by Leonidas Hitimana, Sahel and West Africa Club, OECD and Kristen Cain, Consultant, IFAD in preparing this paper. Contacts: l.hitimana@oecd.org and k.cain@ifad.org respectively.

Democratic Republic of Congo in the South. Some 60% of the population in these areas is estimated to live on less than the lower poverty line of \$1 a day. Three-quarters of these are estimated to live in rural areas and to depend on agriculture as their main source of livelihood and employment – primarily as producers, but also traders or small-scale artisans. Most agriculture in WCA, and indeed in SSA, is undertaken on smallholder farms of 2-10 hectares in size: there are around 80 million smallholder farms in sub-Saharan Africa, providing up to 80% of total agricultural production. Most WCA cotton is produced on such smallholder farms, as a cash crop combined with other crops and economic activities. Women play an important role - contributing up to 80 per cent of total agricultural production and playing significant roles in cotton production (planting, weeding, etc). Mostly, women are employed as labour in the cotton farm of their husbands due to historic obstacles for women to access the necessary land and inputs to engage in cotton production. However, they also play major roles in processing, making textiles and trade.

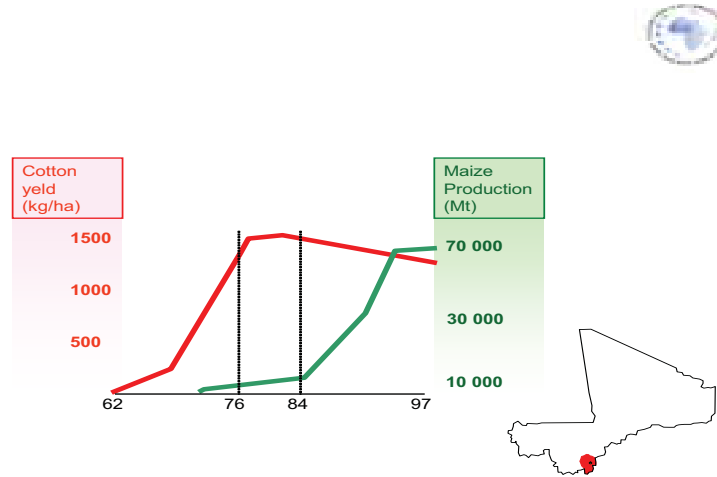
This WCA region is characterised by a process of rapid demographic, social, agricultural and economic transformation, with population expected to double by 2050. The 24 countries of the West and Central Africa (WCA) region have a total population of 333 million, 60 per cent of which are considered 'rural'. Thirteen of the 24 countries are among the bottom 22 of the Human Development Index. Some 60 per cent of the population of the region lives on less than a dollar a day and the majority still depend on agriculture for their livelihoods. Most of the poor still live in rural areas and depend on agriculture and smallholder farmers constitute a majority of the rural poor.

While economic growth has averaged around 5% in the last 10 years, the region still faces numerous serious challenges, including rising food and energy prices, a high proportion of countries facing governance problems or armed conflict, the effects of climate change and now the fallout of the global financial crisis which together may severely compromising food security and sustainable rural development. In this context, building on remunerative agricultural commodity value chains, such as cotton, and establishing ways in which to add value to increase incomes and increase poverty-reduction impacts through increased agricultural productivity, better functioning markets and processing is increasingly important.

Rising prices, in particular, have hit poor rural people in SSA hard in the recent past - many of whom are net food consumers so have been unable to take advantage of agricultural price rises. In the first quarter of 2008, global wheat and maize prices increased by 130% and 30 % over 2007. Opportunities to add value to agricultural products and build income earning opportunities for the rural poor are needed. In addition, medium to long term investment is needed in the sector, in food crops and in other agricultural products that provide added-value and increased cash incomes are required in WCA if poverty reduction targets are to be reached. There is a growing international consensus, supported by the UN General Assembly and by the Alliance for a Green Revolution in Africa (AGRA), that, much like occurred in Asia, a 'Green Revolution' will be needed that dramatically increases productivity to reduce significantly poverty and achieve the Millennium Development Goals (MDGs) in SSA by dramatically increasing productivity. This requires increasing medium to long term investments in African agriculture and increasing access to innovation and technology – particularly for smallholder farmers. Indeed, according to current estimates, external public financing for development in Africa needs to rise to US\$72bn per year to support the achievement of the MDGs by 2015, and as much as US\$ 8 billion will be needed solely for African agriculture (UN MDG Africa Steering Group 2008).

In the context of these challenges for poverty reduction and agriculture in SSA, this paper poses the question: 'What is the contribution of cotton production – largely undertaken by poor smallholder farmers in WCA - processing and the textiles industry, and trade?'

Figure 2: Correlation between maize and cotton production, Sikasso zone (Mali)
1962 – 1997



Source: SWAC/OECD 2005

IFAD'S PROGRAMME TO PROMOTE RURAL DEVELOPMENT IN WCA

At this point, it is useful to devote a few words to present IFAD, its mandate and programme to invest in rural development and why poor smallholder farmers are at the centre of the agricultural and rural development programmes it supports.

IFAD's goal is to empower poor rural women and men to achieve higher incomes and improved food security. IFAD's Strategic Framework 2007-2010 outlines 6 priorities to enable poor rural women and men to have enhanced access to, and have developed skills and organization required to take advantage of: (i) natural resources – land and water, (ii) improved agricultural technologies and effective production services, (iii) a broad range of financial services, (iv) transparent and competitive agricultural input and produce markets, (v) opportunities for rural off-farm employment and enterprise development and (vi) local and national policy and programming processes.

IFAD's programme in WCA covers 24 countries – including 19 active country programmes and 47 IFAD-financed investment projects. In WCA, IFAD has a portfolio of more than US\$ 1.2 billion (a programme of work that is increasing by 10% or more per year). Specifically, to address rapidly rising food and energy prices and increase smallholder farmer productivity, in 2008 IFAD has reprogrammed some US\$ 200 million to boost agricultural production and marketing – largely by applying a value chain approach to increasing smallholder agricultural production, productivity, marketing and hence increasing smallholder farmer incomes.

Intended beneficiaries and partners of IFAD include the rural poor and their organisations, especially women, youth and indigenous peoples. Specific priorities for IFAD in the WCA region in the coming years include: building effective pro-poor agricultural value chains, strengthening capacities of rural poor people and their organizations, improving equitable access to productive natural resources, innovations and technologies and increasing access by rural people to financial services and markets. Given our interest in pro-poor value chain development, the example provided by the cotton production system based on smallholder farming and cotton commodity chain development in WCA over the last several decades provide useful insights.

IMPORTANCE OF COTTON FOR LIVELIHOODS AND AGRICULTURAL TRANSFORMATION

Returning to cotton, between 1-2 million small family farms of 2-10 hectares produce cotton as part of diversified rural livelihood strategies in WCA, and some 10-16 million people are estimated to be involved in the cotton sub-sector in the region. Cotton is one major cash income generator for these small farms. It has sometimes been the only viable cash crop, particularly in Sahelian zones, although this may now be changing with several cereals staples becoming cash crops in the context of increasing prices and demand. Most of these farmers are poor by international standards. However, farmers in cotton zones are often better off than farmers elsewhere due to greater access to inputs, innovation, technical advisory services, and availability of organised production and marketing chains. In these zones there is evidence that the cotton boom was accompanied by a boom in cereals production.

Evidence exists that there has been an 'agricultural revolution' in cotton production zones, with cotton driving a process of increasing extensive agricultural production (increasing land area farmed) on the one hand and also intensive production of cereals as cash crops for urban markets on the other – using inputs and technology provided through the cotton production system to intensify cereals production on other fields. Indeed, analytical work by the SWAC/OECD has demonstrated that there is a correlation between cotton production, particularly in the CFA zone, and: (i) access to upstream and downstream agricultural services and innovation by small family farms: an agricultural revolution? (ii) increased cereals production (iii) institutional development / producer organisations (iv) existence of infrastructure and (v) access to services such as schools, health centres, pharmacies, etc.

This correlation is linked to the commodity chain development approach and 'cotton production system' established, particularly in the CFA zone. Support for institutional development in cotton production areas has facilitated the rise of strong producer organisations that can negotiate on behalf of their members and the sub-sector at national, regional and international levels. Building on strong cotton producer organisations at the country level, such as the UNPCB (Union National des Producteurs de Coton du Burkina Faso) in Burkina Faso, there is now a dynamic regional cotton producers' organisation bringing together cotton producers in several countries of WCA – APROCA (Association des producteurs de coton africains/African Cotton Producers' Association)⁶.

Demonstrating the importance and potential of processing cotton into textiles for the regional market, the artisanal textiles industry is the second employer in West Africa. This is particularly important in Nigeria and Ghana, where most of cotton produced in the countries is used by local textile industries. Opportunities to foster the expansion of this industry should be explored on the basis of a careful economic assessment of regional demand for WCA textiles and the availability of public and private investment resources. The United Nations Industrial Development Organisation (UNIDO), through its South-South Initiative, is encouraging the expansion of this industry (see Section on Increasing Productivity pg 29). Furthermore, West African Economic and Monetary Union (WAEMU) has declared its ambition to increase the use of WCA cotton by the regional textiles industry to up to 25% of cotton produced in the region thus increasing processing capacity in the region significantly by 2010. This objective may still be pertinent in the long term subject to market conditions and sufficient investment, even though it is unlikely to be achieved as hoped by 2010.

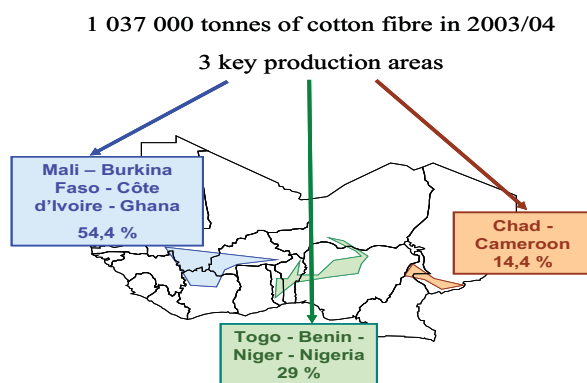


⁶ Website: www.aproca.net

COTTON PRODUCTION ZONES IN WEST AND CENTRAL AFRICA

Cotton is produced to some extent in Benin, Burkina Faso, Cameroon, Chad, Côte d'Ivoire, The Gambia, Ghana, Guinea, Guinea Bissau, Mali, Niger, Nigeria, Senegal and Togo. The main cotton producing zones in the region are indicated in Figure 3 below. There are three main zones of cotton production as shown in the map. While some cotton is produced in most countries in WCA and has in some cases been part of diversified smallholder farming systems for centuries (e.g. Mali), the bulk of production is concentrated in the semi-arid Soudano-Sahelian savanna which has increasingly variable rainfall in the context of climate change. Cotton is suited to this climate and it is a key cash crop for small farmers in these areas. The CFA Franc zone has benefited from long term investment in structured national cotton commodity chains. This zone alone produces some 80% of the region's cotton. Cotton is particularly important for the 5 countries where it has ranged from 5-10% of GDP – Mali, Benin, Burkina Faso, Chad, and Côte d'Ivoire. Most of the rest of WCA cotton is produced in Nigeria.

Figure 3: Main cotton production zones in West and Central Africa



Source: Sahel and West Africa Club/OECD

produced and smaller amount of debris, despite its technically lower quality than traditional WCA cotton.

According to FAO, the CFA Franc zone in WCA produced between 4-6 per cent of total cotton (seed and lint) produced in the world in 2003. The region now produces over one million tonnes of cotton, compared to 200 000 tonnes in the 1970s. Most is exported as seed or lint, with the key exception of Nigeria which consumes most of the cotton produced (either processed into oil or textiles). West and Central African cotton exports progressively rose from 1961-2001, and reached some 13 per cent share of the international market in 2004-5 (if taken as a region, WCA recently became the second exporter after the US, overtaking Ukraine).

Certain economies, particularly those in the CFA Franc zone, are highly dependent on cotton exports for foreign exchange earnings. In 2004, cotton accounted for almost 50 per cent of Burkina Faso's national export earnings, between per cent for Benin, 36 per cent for Chad and 14 per cent for Mali. However, producers saw prices on international markets fall below the cost of production in 2002 to less than 35 cents a pound. Despite a subsequent recovery of the price of cotton, international prices remain volatile. Furthermore, the medium-term outlook for prices to African cotton producers looks bleak given the failure

In the last 25 years, WCA farmers increased land areas for cotton cultivation in response to market liberalisation falling yields and the need to maintain incomes in the face of a long term downward price trend on international markets, for which most WCA cotton was destined (save for the rise for a few years from 2003). This was due to increased use of synthetics, subsidised cotton production - particularly in the US and Europe - and more recently increased availability and marketing of more uniform BT cotton, well-suited to textile factory production needs due to the conformity of fibres

to conclude the Doha Round of trade negotiations and thereby to eliminate subsidies provided to cotton producers in key cotton producing developed countries.

Small farmers in WCA are, however, flexible, opportunistic and responsive where they have the capacity and incentives to change the mix of agricultural products they produce. Recent trends indicate that cotton farmers are indeed switching to food grains given dramatic price rises for grains in the last 2 years. Final seed cotton production estimates across the region indicate 2007/8 was the worst year for production since 1994-5. This shows the remarkable capacity of West and Central African smallholder farmers to adapt strategies to respond to market demand and, where conditions allow, take up new productive activities in the face of price volatility.

THE C-4 COTTON PRODUCING COUNTRIES AND THE WTO: BENIN, BURKINA FASO, CHAD AND MALI

Cotton has been of critical importance for the national economies and rural livelihoods particularly in Benin, Burkina Faso, Chad and Mali, the "C-4 countries" that led the challenge against cotton subsidies at the WTO from 2002. These countries have been highly dependent on cotton exports for scarce foreign exchange.

Much evidence has been collated to show that cotton subsidies in developed countries have done significant damage to cotton farmers in developing countries, particularly West Africa.

The World Bank estimates that the full removal of cotton subsidies and tariffs would raise the price of cotton in international markets by an average of 12.9 percent. The global boost to economic welfare that could be achieved by removing subsidies has been estimated at US\$ 283 million per year and, for sub-Saharan Africa, US\$ 147 million. With the removal of subsidies, the global share of the WCA region's cotton exports would rise from 12 to 17 per cent.

The inadequate efforts to reform these cotton subsidies to date limits the profitability of cotton for WCA farmers as subsidies in rich producer countries artificially depress the international price of cotton for all exporters. A serious reform of trade regulations to oblige states to eliminate subsidies in rich countries and allow poor countries some mechanisms to protect strategic products and sectors from international competition (such as cotton and textiles) is needed to address the problems faced by cotton and other strategic African agricultural products on international markets so as to promote development and poverty reduction. However, agreement, if it can ever be achieved, is clearly still some way off.

In any case, a key problem remains: the vast majority of WCA cotton, 98 per cent according to some estimates, is exported as lint without adding value: raw, carded or combed lint. There is therefore a serious need to reduce dependence on volatile international markets, to promote regional markets for SSA cotton, support the development of regional textiles industries where they are economically viable and, ultimately, find alternatives to cotton to provide a cash crop that adds value to agricultural production.

INCREASING PRODUCTIVITY: 'COTTON MADE IN AFRICA' AND OTHER INITIATIVES

A series of initiatives have been developed in recent years to respond to the demands of the C4 countries and support increased productivity and profitability of cotton production, processing and trade in WCA. Here, we will examine three different types of initiative.

First, the USAID-funded West Africa Cotton Improvement Program (WACIP) is a US\$ 27 million programme implemented in collaboration with the International Fertilizer Development Center (IFDC). It focuses on: (i) enhancing the capacity of four of the nine countries in the “Franc Zone” of WCA (the C4: Mali, Burkina Faso, Benin, and Chad), (ii) improving cotton quality and productivity, (iii) adding value to CFA Franc Zone cotton lint, (iv) engaging key stakeholders on important policy and institutional issues, (v) assessing world markets for organic and Fair-Trade cotton lint and related cotton products and (vi) examining markets for cotton ginning by-products such as cottonseed, cottonseed oil and cake, and ingredients in soap production⁷.

Second, the cotton ‘Made in Africa’ project aims to improve cotton production towards sustainable production, enhance the competitiveness of African cotton and develop a new dimension of corporate responsibility. The cornerstones of this initiative are (i) to assist cotton businesses to establish a clear picture of the baseline situation of cotton farming in their growing regions; (ii) to develop a verification system, starting at the level of ginning operations which obtain cotton from thousands of smallholders through either state-regulated regional monopolies or contracted cotton farmers; (iii) to separate transporting and shipping from ports in Africa pose a challenge because cotton from all national cotton businesses come together and are handled there; and (iv) to ensure traceability of WCA cotton through the value chain. The flow of cotton will therefore be transparent – a critical element to ensure that, for example, European demand actually gets through to poor smallholder producers in Benin or Zambia. The expensive process of certifying all supplier businesses in the value chain has been ruled out for now⁸.

Third, the South-South Initiative on Cotton seeks to support productive capacity-building in the cotton-textile garment value chains and networks in Africa. Here, the United Nations Industrial Development Organisation (UNIDO) through its South-South Initiative, is planning a capacity building programme to ensure sustained competitiveness of the Cotton-Textile-Garment sector in the 11 selected cotton-producing countries of Benin, Burkina Faso, Cameroon, Chad, Côte d’Ivoire, Mali, Nigeria, Senegal, Uganda, United Republic of Tanzania and Zambia. This programme has three goals: (i) to ensure sustained competitiveness of the cotton-textile-garment sector in African countries, focusing on product innovation and investment promotion; (ii) to contribute to poverty reduction through employment generation and value chain improvement, and (iii) to improve productive capacity-building in cotton processing through south-south cooperation with India and China⁹.

DEVELOPING THE WCA TEXTILES INDUSTRY

Fostering the development of the WCA textiles industry at the national and regional levels constitutes an important opportunity to add value to cotton production. However, this approach is probably of limited scope given the comparative advantage held by certain textiles producers in the current context of relatively open international markets and absence of major trade barriers or protection for textiles in WCA. Despite competitive labour costs and high quality cotton, cotton and textile companies cannot meet the challenges of international competition on a quota-free cotton market. Most of the textiles factories and equipment is now antiquated. WCA cotton often holds a relatively high percentage of debris that needs to be cleaned and fibres are not of uniform length and width. In addition, cheap imports of African prints from Asia have reduced demand

⁷ For further information on WACIP see: <http://www.usaid.gov/press/releases/2006/pr060615.html> and http://mali.usembassy.gov/wacip_01.09.07

⁸ See: <http://www.cotton-made-in-africa.com/Home/en>

⁹ See: <http://www.unido.org/index.php?id=o84840>

for regional and local products, while imports of used clothing have fuelled preference for western style apparel. WCA mills and garment manufacturers have been criticised by certain observers for displaying limited “market intelligence” to date, particularly regarding knowledge of the regional market, industry and trade opportunities (i.e. assessing demand for products beyond local markets, analysing sales and sourcing).

In addition, given the clear economic and price comparative advantage of textiles produced in other regions such as Asia, in order to develop the WCA textiles industry, some degree of protection regional textiles industries from international competition may be required, albeit within the context of abiding by international trade regulations set by the WTO. With the African population expected to double to 1900 million by 2050, there is potentially a massively expanding market available for capture by African cotton products. But this will not happen if the industry is not competitive on price, quality and style.

In addition, there is a need to mobilize additional private as well as public investment to support the development of this industry. The need to deepen public-private partnerships to mobilise investment and develop an efficient regional textiles industry that satisfies regional demand while responding to niche market opportunities is evident if the region is to find ways to add value to regionally produced cotton in the face of competition and economic comparative advantage held by other regions of the world, in particular Asia and North America.

DRAWING VALUE-ADDED FROM NICHE MARKETS: OPPORTUNITIES IN FAIR TRADE AND ORGANIC COTTON

Niche markets: Fair Trade Cotton and Textiles

Albeit a niche market, Fair Trade cotton volumes are rising: they rose from 1,900 tonnes in 2006/07 to 3,000 tonnes in 2007/08. This output is marketed at a premium of 46 per cent to the world price (around 180 CFA/kg for seed cotton). In Senegal, Sodefitec hopes to market 25 per cent of its output as Fair Trade.

However, the development of Fair Trade cotton is limited by the fact that ‘Fair Trade’ registration requires a producer to meet a wide range of specific standards regarding labour standards and other conditions. Increasing numbers of individual consumers in richer countries as well as large companies have become interested in certified organic cotton and in maintaining the social standards within the value chain.

In Mali, the Compagnie Malienne pour le Developpement des Textiles (CMDT) and Max Havelaar launched an organic cotton programme in 2002. By 2007, 3,800 farmers were producing 800 tonnes of organic cotton earning 34 CFA extra per kilo of cotton. The Fair Trade Division of CMDT aims to produce 3,000 tonnes of organic cotton in 2009.

Niche markets: Organic Cotton

Organic cotton has high potential for development and increasing value added to cotton produced in WCA. Thousands of farmers in 15 countries worldwide are already involved in organic cotton production, producing globally approximately 10,000 tons of fibre annually. At least nine countries in SSA, of which four are in WCA, produce organic cotton (see Figure 4 below). Three of these four countries in WCA are among the major producers of cotton in the region demonstrating their efforts to diversify and seek niche markets to bolster prices in the face of international cotton price volatility. As yet, however, organic cotton is produced in relatively small quantities compared to non-organic cotton in these countries. Organic cotton, using natural rather than chemical inputs, pesticides and fertilisers, is envi-

regional markets. Building on the lessons of the strengths of cotton production systems and commodity chain support programmes in CFA countries over the years, a key response is to promote crop and livelihood diversification by establishing efficient production support systems and value chain development for other remunerative crops – including selected staples and crops where regional demand is high. Indeed, many farmers recognise that they plant cotton primarily to access inputs, technical support, school, health and credit facilities through cotton production support systems. If the same facilities were allocated for other crop commodity chains, such as key food staples that have strong market value in the region in the current economic climate of high food prices (e.g. maize, rice, sorghum) the production plans of many farmers could change dramatically, with beneficial effects for incomes, poverty reduction and food security. This calls for governments and donors to establish a rational strategy to support farmer diversification in WCA. Some donors and governments are already moving in this direction, for example the Ghana Northern Region Growth Programme, financed by IFAD and ADB with more than US\$ 90 million, that strengthens a number of food crop value chains where there is strong national and regional demand and the links between private and public sector actors with Northern Region smallholder producers right along the value chain.

CONCLUSIONS AND STRATEGIC DIRECTIONS

Following the review above, we draw the following conclusions that lead to the identification of proposals and strategic directions for the development of the cotton sub-sector in WCA.

There remains a need to increase investment in smallholder agriculture in WCA, supporting existing farmer strategies and opportunities, recognising the role of cotton production, processing and trade in regional development and poverty reduction. Recognition of the role of cotton production support systems would be helpful in stimulating productivity, increasing access to services and innovations and production of food crops. Providing incentives to build production support or value chain systems to food crops and other market opportunities should be considered – while facilitating producers' capacities to shift production to more remunerative products or alternative livelihood opportunities as market opportunities change. IFAD is providing support to smallholders, governments and private sector players in these shifts through its increasing number of value chain development projects and programmes in WCA – both for food and non-food agricultural products.

Investing in the development of the regional textiles industry in WCA and, more broadly, in SSA could also be beneficial. Opportunities may exist to expand the WCA textiles industry for regional and international markets to add value to cotton produced in the region and increase producer incomes. WAEMU had an ambitious plan to mobilise support for developing the WCA textiles industry in 2004 but did not raise the primarily private sector resources needed. This indicates that real opportunities to expand the textiles industry may be limited in the face of the comparative advantage of cheaper Asian textiles unless some degree of regional market protection can be implemented. A careful economic assessment is required before establishing the scale of investment appropriate in a WCA textiles industry. As for the developing niche markets, Fair Trade and organic cotton may constitute more realistic options for developing both cotton and textiles markets. These should probably be expanded but are unlikely to extend beyond 20-25% of cotton production and trade given the balance of international demand for standard and Fair Trade/organic WCA cotton.

Finally, it is critical to promote livelihood diversification among cotton farmers and the availability of alternative rural livelihoods, to increase livelihood security and capacity to take advantage of emerging opportunities in national, regional and international markets. At the same time, work must continue to address the negative impacts of international

trade and agricultural policies – particularly subsidies – on the price and demand for African agricultural products. This calls for a successful conclusion of the Doha Development Round of Trade negotiations as well as considering the implementation of targeted measures at the regional level to protect strategic products and the nascent textiles industry in WCA – albeit abiding by existing WTO regulations which allow for such policies within certain limits.

Sisal: Small farmers and plantation workers

David Machin, UK

INTRODUCTION.

Sisal is a crop that has traditionally been produced on large plantations, which have been quite pleased to produce sisal fibre exclusively from the land utilised. On such estates the sisal leaves are mostly brought to central processing facilities where the fibre, comprising only 4% of the harvested leaf is extracted from the leaf using wet processes. The waste remaining (96%) is either discarded causing environmental problems to water tables or used as a mulch in sisal fields.

In Latin America much sisal has been processed dry in the field using small machines called "Raspadoras"; often the sisal comes from large estates but some is cultivated by smallholder farmers.

With the economic pressure on sisal fibre production as well as the need to increase food production, achieve poverty alleviation and improve environments in the arid and semi-arid areas where sisal is best grown; new approaches to sisal farming need to be developed.

This paper indicates how this challenge can be addressed.



Sisal potential. The attached figure indicates the many potential ways in which sisal can be utilised.

It is therefore proposed that small scale cultivation and processing of sisal can therefore be practised to benefit from a range of the potential benefits indicated here. In particular at the first stages it is proposed that involved farmers should focus on:-

1. Production of fibre and the local processing of this for handicrafts and local products.



Hedge sisal is Shinyanga region of Tanzania

2. Sun drying of sisal waste to produce animal feed or Biofuels substrate, using the model developed in Eritrea. Intercropping of land between sisal rows for subsistence or cash crops.

Recent experience in East Africa and in particular Tanzania, Kenya and Eritrea suggests that small holder sisal production can be developed using:-

1. Hedge sisal grown around fields and along roadsides. (the Tanzanian sisal board estimate that over 10,000 tones could be processed in Northern Tanzania using this source)

2. Establishment of smallholder sisal farms with the rows of sisal being intercropped with other cash crops such as cassava, sweet potatoes, pulses, grains, vegetables, herbs, etc.

3. Plantations sub divided using the Katani model; where the estate lets its land to smallholders and the estate owners (Katani, Tanzania) provide technical assistance, harvest the crop, process the leaves and market the fibre. The estate charges the farmer for these inputs from sales of fibre and returns excess profits to the smallholder.



Sundried sisal waste for use as animal feed or Biofuels in Eritrea



Smallholder farmer on sublet part of Katani Estate Tanga. Tanzania

OXFAM MODEL.

On the basis of the above experience a model sisal farmer concept is being developed in the Shinyanga region of Tanzania with the cooperation of the Tanzanian Government, Katani Ltd and Oxfam. This model is being developed as an agricultural scale up project and will aim to establish a 100,000 farmer operation in the region over 10 years.

OXFAM HOUSEHOLD MODEL

1. 1000 000 households
2. Fifty percent of households participating
3. Farming Unit
 - 1-2 ha per household
 - 4 000 sisal plants/ha
 - Time to harvest 2.5-3 years
 - Row width 5-6 m
 - Land intercropped with cassava, sweet potatoes, beans, herbs, grain crops, etc

FARM PRODUCTION

1. Yr 1 and 2 using hedge sisal
2. Year 3 using planted sisal plus hedge sisal
3. Inter-cropped crops and livestock fed using sisal feed
4. Intensively housed livestock producing of biogas with waste used as fertilizer

SUPPORT PROVIDED TO PARTICIPATING HOUSEHOLDS

1. Each village to have raspadora to process sisal leaves, as well as fiber washing tanks and drying racks.
2. Each village to have sisal feed drying areas
3. If cassava production involved engine to also be used to drive cassava chipper and drying area to be used to dry cassava chips.
4. One villager trained as para-extension officer with farm as demonstration farm.
5. One professional extensionist per 40 villages.
6. A sisal nursery per village run by school or women's group.
7. KATANI (commercial company) to cover sisal purchase, marketing, storage, combing and bailing.

BENEFITS AND BENEFICIARIES

1. Households increased incomes from sisal products \$2 000 pa from yr 4 plus value of other crop and animal products.
2. Women and children's groups running nurseries, feeding livestock and producing saleable sisal fiber products.
3. National economy have increased GNP, export replacement and potential, Carbon trading.
4. Regional and national environment improved with reduced drought impacts.

Regional visits and discussions with involved parties have produced the following proposal for which Oxfam are currently sourcing funding.

OVERALL CONCLUSION

The financial appraisal and cash flows for the different village group of the Oxfam model sisal project indicate that using half the revenues generated from the sisal products alone would be sufficient to pay back the loans taken out by all the farming groups within 4 years.

The other half of revenues as well as income from other enterprises on the smallholding including intercropping and animal farming as well as added value potential of all products will be available to smallholders for living expenses and to finance other developments.

Clearly participating smallholder families could expand the size of their units in line with their capacity to manage the land and so increase the income generated.

It is anticipated that this project would have a significant effect on the local environment and provide a significant increase in income for participating farmers and the region in general.

Wool and other animal fibers in South America

Roberto Cardellino, Delta Consultants, Uruguay and Joaquín Mueller***

INTRODUCTION

The South American sub-continent is a vast and variable area that includes 12 independent countries and many different ecological conditions, from tropical areas in the north to temperate climates in the centre and semi-desert conditions in the south. (Map 1).

Map 1 – South America



Table 1 – The importance of animal fibers in South America

Production in kgs	
Wool	143 700 000
Alpaca	4 055 595
Llama	3 342 866
Mohair	825 000
Vicuña	5 580
Guanaco	1 500

Source: Cardellino,R. based on SAGPyA, SUL, ODEPA, IICA, IWTO

Wool is by far the most important animal fiber in South America; however other animal fibers like alpaca, llama, and mohair are also produced in large quantities, whereas vicuña, guanaco, angora and cashmere have a great potential for development but the amount produced at present is low (Table 1).

The production of wool and other specialty of fibers is concentrated in the Southern Cone of the sub-continent (Argentina, Uruguay, Chile and south of Brazil), where climate is temperate or deserted. Further north, with the exception of the Altiplano region, (the highlands of the Andes mountains), the production of these animal fibers is not possible due to the tropical climatic conditions.



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Map 2 – South America: sheep producing areas



THE PRODUCTION OF WOOL

The main areas in South America producing wool are shown in Map 2.

Three main sheep producing areas can be distinguished. The largest one, indicated as wool producing sheep area, includes the majority of Argentina, southern Chile, Uruguay and southern Brazil. In that area, wool or dual purpose sheep breeds (derived from the merino) are the more important ones.

The second area, the criollo sheep region, includes the northern part of Argentina, and the Altiplano regions of Bolivia and Perú.

There is a third area, specifically in the northeast of Brazil (a very dry region), where woolless hair sheep are kept for meat and leather production.

The present population of sheep and the estimated wool production in South America are presented in Table 2.

Table 2 – Sheep population and wool production in South America

Country	No sheep (mill)	Wood production (m kg, greasy)	Type of wool	Prod System
Argentina	16,0	65,0	Fine - Medium	Commercial/smallholders
Uruguay	10,4	41,0	Medium - Fine	Commercial
Chile	3,9	11,2	Medium	Commercial
Brazil	3,5	10,5	Medium	Commercial
Perú	14,7	12,0	Coarse - Medium	Smallholders
Bolivia	9,0	4,0	Coarse	Smallholders
Total	57,5	143,7		

Source: Cardellino, R. based on SAGPyA, SUL, ODEPA, IICA, IWTO

The countries more specialized in the production of wool (Argentina, Uruguay, Chile and Brazil) have close to 60% of total sheep numbers, but account for 85% of the wool produced, which corresponds to fine and medium good quality wools.

Two well defined socio-economic regions involved in the production of wool can be distinguished in South America:

1. Small holder production systems. These correspond to low input, low productivity small farms with subsistence economies. The predominant breed is the criollo (derived from the original sheep introduced by the Spanish settlers) or non-defined criollo crosses. Normally these peasants (native population) would also have as part of their way of life, a few camelids and goats.

Main areas where these types of production systems can be found include (see Map 3):

Bolivia, in the Altiplano region at 3000-4500 masl , involving mostly native communities.

Perú, in the Sierra Region (Altiplano), with 43% of very small producers and 32% of peasant communities.

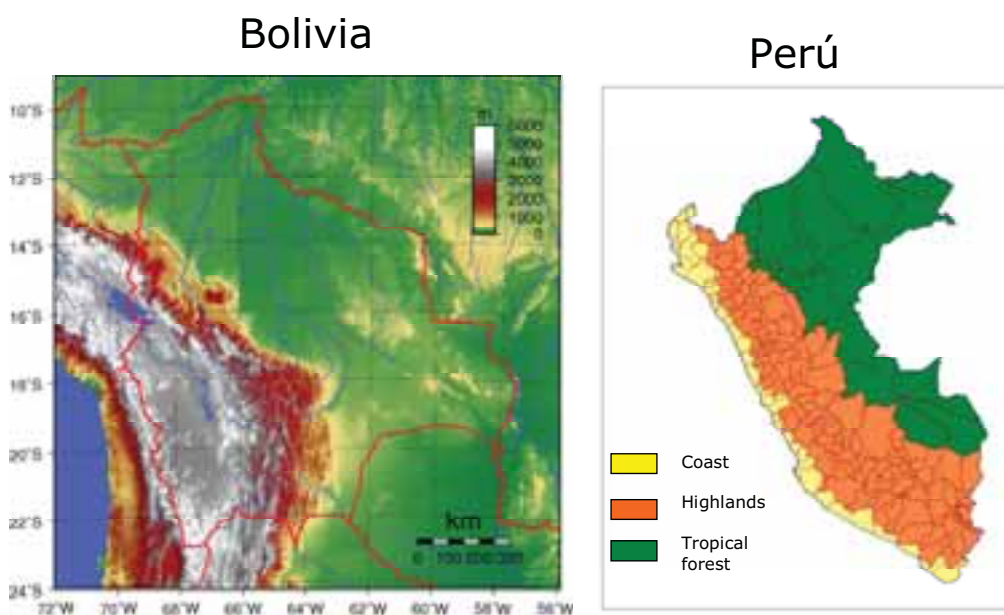
Argentina, in the northwest region (12% of the total) with subsistence livestock systems.

2. Commercial production systems. These include farmers whose main objective is not the subsistence, with a variety of sizes depending on the region, but oriented mainly to the production of wool as a business.

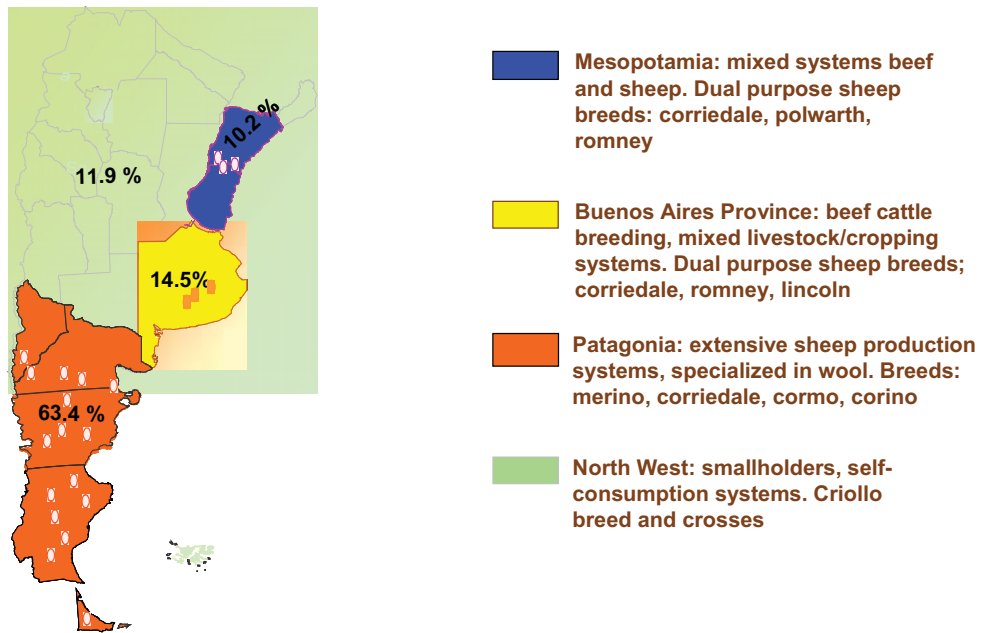
Main areas of these production systems include:

Argentina, in the regions of Patagonia (very dry and cold), mesopotamia (in conjunction with beef cattle) and Province of Buenos Aires (in conjunction with agriculture). It includes

Map 3 – Geographic regions



Map 4 – Argentina – Distribution of sheep by zones and productive systems



Source: SAGPyA, Departamento Ovinos y Lana, 2002

an approximate number of 50.000 growers. Wool exports accounted for 230 mill US\$ last season.

Uruguay, with 38.000 growers in mixed farms with beef cattle, running dual-purpose sheep. Wool exports reached 240 mill U\$ in 2007/08 season.

Sheep breeds in Uruguay: predominance of “Dual Purpose” breeds

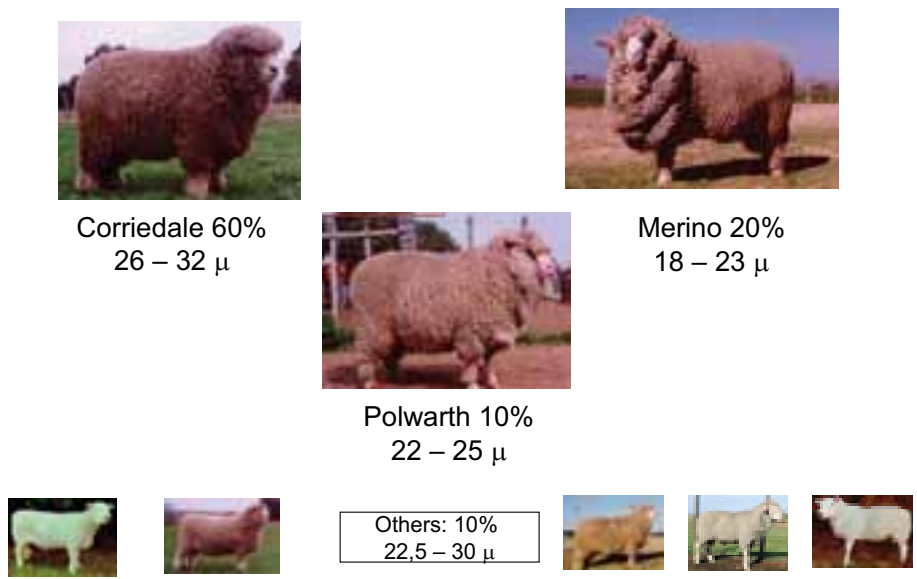
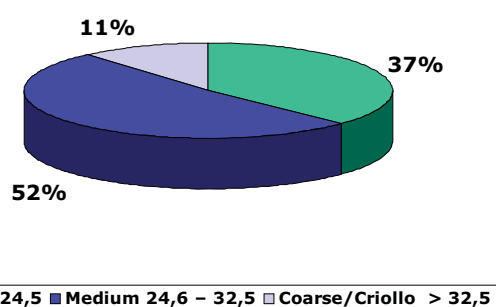


Table 3 - Wool production by fineness in South America. (mkg greasy)

Country	Fine <24,5	Medium 24,6 - 32,5	Coarse/Criollo >32,5	Total
Argentina	40,3	22,7	2,0	65,0
Uruguay	12,0	27,0	2,0	41,0
Chile	0,2	10,8	0,2	11,2
Brazil	1,0	8,5	1	10,5
Perú		5,0	7	12,0
Bolivia			4	4,0
Total	53,5	74,0	16,2	143,7

Sources: Cardellino, R. based on FLA, SUL, ODEPA, IICA, IWTO

Figure 1 - Wool Production by Fineness in South America. (mkg greasy)



Sources: Cardellino, R. based on FLA, SUL, ODEPA, IICA, IWTO

Brazil, with 40.000 growers running mixed farms located in the southern region, with predominance of dual-purpose sheep and wool exports of 25 mill U\$S

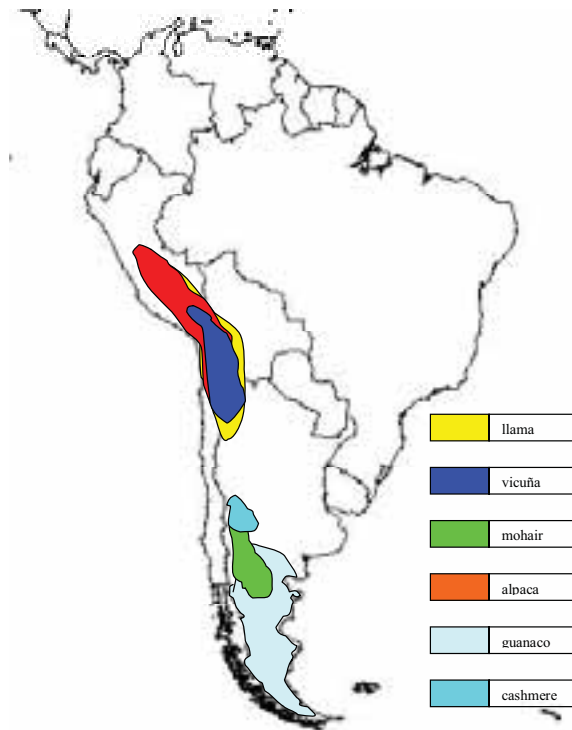
Chile, with 60.000 growers in total. The patagonian region concentrates 60% of the total sheep population, involves medium to large farmers and dual purpose sheep breeds. Wool exports represent 15 mill U\$S

The types of wools produced in S. America, by fineness, are shown in Table 3.

THE PRODUCTION OF OTHER ANIMAL FIBERS

In South America these fibers are produced almost exclusively by smallholders in low input systems where they are critical for the subsistence of its producers by contributing raw material for homemade clothing, handcrafts for local markets or fiber for the textile industry. Most fiber production systems are located in marginal areas with goats and camelids grazing natural rangelands. Alpacas, llamas and vicuñas are typically found in high altitudes of the central Andes while goats producing mohair or cashmere and guanacos are largely found in the Patagonian desert (Map 5). The characteristics and relevance of the production of each of these “special” animal fibers in the subcontinent are described here.

Map 5: Approximate main distribution area of South American camelids and fiber producing goats



Alpaca

The Alpaca (*Vicugna pacos*) is a domesticated South American camelid species whose wild ancestor is the vicuña. Alpacas are raised in the highlands of Peru, Bolivia and Chile. More than 80% of the world's alpaca population can be found in southern Peru, northwest of the Titicaca lake at 3,700-5,000 mt of altitude. The alpaca is a symbol of Peruvian national identity. It is calculated that more than 120,000 families live directly from the alpaca as their main income and subsistence, and indirectly 3 times more than this figure. 85% of the alpacas are run by smallholders with less than 50 animals each, or are kept in farmer communities. Alpacas are particularly prized for their fiber, which is noted for its fineness, softness, light weight, exceptional warmth, hygroscopic features, resistance, elasticity, prestige and

natural colors. Its fabric is soft to handle and shiny in sight. The soft touch is related to the fineness of the fiber but also to the arrangement of the scales along the fiber. "Baby" alpaca fiber diameter averages 22 mic and alpaca "fleece" averages 26 mic. Both types of fiber make up 50% of the total clip; the rest is considered inferior with coarser fiber diameter. The traditional use of alpaca has been in the apparel clothing industry for men. Twenty three alpaca colors are recognized but most (in Peru 86%) of the alpacas are white, the rest ranging from cream to black. An adult alpaca produces 1.5-2.8 kg of fiber per year, enough to make four sweaters. Two alpaca breeds are recognized, huacaya and suri. The former breed produces a spongy type of fleece with fibers growing perpendicular to the skin. The latter have a fleece with long rolling staples hanging parallel to the skin with more lustrous and silkier fibers. In general suris are more demanded and can be found at lower altitudes than huacayas, therefore sharing grazing land with sheep and cattle. About 90% of alpacas are of the huacaya breed. Alpaca is the main special fiber produced in South America.



Llama

The llama (*Lama glama*) is the other domesticated South American camelid species, its wild ancestor being the guanaco. Both, llamas and guanacos are larger animals than alpacas and vicuñas, therefore more meaty. Most llamas in South America are found in Bolivia and Peru. Bolivia has the largest llama population, about 2.4 million, largely on the high-plateau (Altiplano) at 4000 mt of altitude in the western of the country.



Peru with 1.2 million llamas is the second producer, while Argentina ranks third. It is estimated that in Bolivia there are 54,000 producers, 80% having less than 90 llamas each (José Campero Marañón 2007, personal communication). Llamas are multipurpose animals; they are raised for their meat, power and fiber. As with alpacas, there is a strong cultural tie between llamas and their producers and communities. In many cases llama products are crucial for the subsistence of

a community. (Rodríguez and Quispe, 2007). The fiber produced by llamas is not as fine as that of the alpacas. In Bolivia adult llamas produce fiber with an average diameter of 33 mic, but the fiber is greasy free and may yield up to 93% of its original weight when processed. Llama fiber is extensively used for clothing and handcrafts. Due to its multiple breeding objectives, llamas were selected for high body weight and fleece weight (1.5-3.5 kg) but less for fiber traits such as fineness and uniformity of color. Therefore the pressure to select for white color has been less and llama coat color range from white to black, with shades of beige, brown, red, and roan. Its fleece may be spotted, solid, or marked in various patterns. Two llama breeds are recognized the Q'ara with slim and long bodies and short coat with visible guard hairs, and the T'ampuhlli (in Peru called Ch'aku) which are compact and short bodied with fewer guard hairs and finer fibers. In Bolivia both breeds are equally represented while in Peru the Q'ara breed is dominant (70%).

Vicuña

The vicuña (*Vicugna vicugna*) is the smaller of the two wild South American camelids and its undercoat fibers are extremely valuable and "special", not only for its textile characteristics but also for its rareness and association to exotic environments and culture. After a period of near extinction, the vicuña population recovered substantially in population size in all Andean countries. In Peru the vicuña population is now 140,000 and increasing, as well as in Argentina



with a population of 133,000. Vicuñas are captured, shorn and released using different methods. Although a few vicuñas are kept in captivity systems, in general they are captured during large scale community based events called "Chakus". The procedure is regulated, monitored and documented so that only legal fiber can be marketed and therefore protecting the species from hunting for fiber. This has been particularly important for the fate of vicuñas which recovered from near extinction. At present Peru is producing most vicuña fiber, about 5,500 kg/year, much less is produced in Chile, Bolivia and Argentina (Francisco Rigalt 2008, personal communication). Fiber diameter range 10-15 mic, yarn and fabrics made of vicuña fiber have the highest market price of all special fibers but its production is not easy due to its short staple length and the necessity of separating manually guard and dead fibers from the fine down fibers.

Guanaco

The guanaco (*Lama guanicoe*) is the larger of the two wild South American camelid species and its population is much larger than that of the vicuña. More than 90% of the world guanaco population is in Argentina and the remainder in Chile and Peru. The population of 550,000 guanacos in Argentina are largely concentrated in the southern part of the country (the patagonian desert). Guanacos roam freely in this sparsely inhabited country where sheep production is the main agricultural activity. Capture of guanacos is difficult as they can



easily jump regular fences to escape at very high speed when mustered. Special techniques have been developed in order to capture, calm, shear and release guanacos avoiding unnecessary fear and injury. As with vicunas, strict regulations and monitoring procedures are applied during capture and shearing. Fleece weight is approximately 1 kg in two years growth (Sacchero *et al.*, 2006). Guanaco fiber is not as fine as that of the vicuna but otherwise quite similar, including in its color variations of brown and the presence of dead and guard hair together with the valuable down hair.

Fiber diameter is 16-22 mic for adult animals, removing guard hairs reduces average fiber diameter by 1-2 mic.

Mohair

The third animal fiber of importance in South America is mohair. About 650,000 Angora goats are run in the northwest of Argentina's Patagonia where they produce 500,000 kg mohair of competitive quality. Argentina is among the top world producers of mohair. About 4,500 families make their living on mohair and meat produced by Angora goats. A large proportion of the mohair clip is exported. Only a minor part is processed locally and mohair handcrafts are not common. Mohair is a fiber well known for its luster, resistance, length and smoothness. Notable of Angora goats in this part of the world is the uniformity in color. Almost all Angora goats in Argentina are white, as opposed to central Asian Angora goats where other colors are very common. Angoras are shorn twice a year and produce a total of about 1.5-2.5 kg mohair. Mohair from young animals, (first and second shearing) is much finer (24 mic) than mohair from adult animals (29 mic and more).



Cashmere

In the early 1990's it was realized that the undercoat of many of Argentina's native goats was in fact cashmere. It is estimated that some 700,000 goats in traditional farming systems grow cashmere and potential production is therefore high (estimated to reach 5,000 kg in a few years). Recently a small number of these goat holders started a program of systematic combing their goats in order to extract the undercoat fibers. Results are very promising and the product is being sold to the local and foreign industry. The cashmere collected presents colors which vary from white to black with grey and brown tones being common.

Fiber diameter is as low as 14 mic but averages 19 mic with 25% of animals producing 120 gr combed fiber averaging 17.5 mic (Maria Rosa Lanari 2008, personal communication).



A summary of the production of special animal fiber production in South America can be observed in the next table (Table 4).

Table 4 - Special animal fiber production in South America

Fiber	Animal	Type	Main producer	Farmers	Number of animals	Production (kg)
Alpaca	Alpacas	Domestic	Peru	159 928	3 503 774	4 055 595
Llama	Llamas	Domestic	Bolivia	74 302	4 080 596	3 342 866
Mohair	Angora goats	Domestic	Argentina	4 500	550 000	825 000
Vicuña	Vicuñas	Wild	Peru	100 ^a	319 547	5 580
Guanaco	Guanacos	Wild	Argentina	15 ^a	577 697	1 500
Cashmere	Native goats	Domestic	Argentina	70	700,000	200

^a Management units Source: Mueller, J. based on several sources

FINAL CONSIDERATIONS

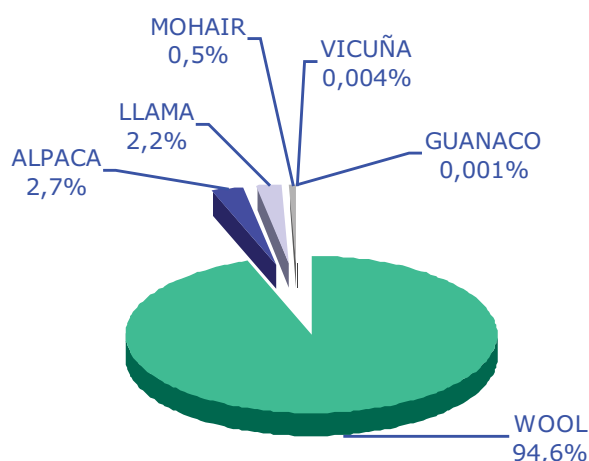
The volume of production of different animal natural fibers in South America reaches more than 150 mill kg, with wool production representing 143.7 mill kg. (see Figure 2)

In addition, the production of natural fibers in South America is very important and with great socio-economic implications. There are more than 600.000 farmers/peasants involved, of which the majority are small holders and subsistence units. However, the number of commercial farmers, particularly those involved in the production of wool in the southern cone is also very important.

The exports of natural animals fibers from South America to other manufacturing countries (mainly China, Germany and Italy) represent more than 600 mill U\$S per year, but there is a very strong early processing capacity (14 combing plants) which constitutes the second producing region after China.

The production, harvesting, transport and early processing of natural fibers in South America also involves a very important source of labor for the people in the region.

Figure 2 - The Importance of Animal Fibres in South America



REFERENCES

- Cardellino, R.C.** 2008 The wool industry in Uruguay. Report to the IWTO Market Intelligence Committee
- IWTO.**- Market Information Report. Edition 2008
- Mueller, J.** 2008. III Seminario sobre Mejoramiento Genético en Ovinos, Salto, Uruguay. La situación en Argentina.
- Rodríguez, C.T. and Quispe J. L.** 2007. Domesticated camelids, the main animal genetic resource of pastoral systems in the region of Turco, Bolivia. In: KA Tempelman and RA Cardellino (Eds.) "People and Animals", FAO, Rome.
- Sacchero, D; Maurino, M. J; von Thüngen, J y Lanari, M. R.** 2006. Diferencias de calidad y proporción de down en muestras individuales de vellones de guanacos de diferentes regiones de Argentina (Lama guanicoe). En: Olivera, D.; Miragaya, M; Puig S. eds. Resúmenes y trabajos "Fortalecer el futuro de los camélidos, una oportunidad para crecer". 4to. Congreso Mundial de Camélidos, Santa María Catamarca, 11 al 15 octubre, p.52.

Natural Fibres in China

Zhang Jianchun. The Research Center of Chinahemp, China

China's farmers produce almost all kinds of natural fibres for processing industries mainly represented by textile industry. Natural fibres are widely and deeply associated with farmers and agriculture. The capacity of the overall textile industry in China is huge. Although China produces an enormous amount of natural fibres, China's textile industry still needs to import great quantities of cotton, wool and flax. Therefore, natural fibres are important with thousands textile workers as well as farmers outside of China who produce different natural fibres.

This paper presents the general situation of natural fibres production and industrial processing. Then I will give our view of a specific fibrous crop, hemp, which we believe can contribute a lot to improve farmers' lives and food security in China and will also help textile industries to produce many more green and functional products to market places and to help consumer demand, the environment and the earth---our common homestead.

The paper is in 3 parts:

1. General
2. R&D in hemp fibres processing
3. Hemp agriculture, hemp industries and their contribution to food security

GENERAL

In China, we have almost all raw natural fibres for the textile industry.

TEXTILE PEOPLE

In China not only produce fabrics of natural fibres but also blend different natural fibres, as well as blend natural fibres with manmade fibres to produce textiles with different performances.

Cotton

Since early last century, cotton has been the most welcome textile material to make fabrics for underwear, shirts, and bed linen as it is soft to handle, warm and so comfortable on your skin. Denim for jeans has been a fabric for fashion since the cowboy era.

Thanks to the rapid development of the textile industry in the last 30 years, the cotton textile industry of China now takes the first position in the world by its volume and production capacity. The following data shows agricultural production and textile production as well as importation of cotton in China.

Cotton

- Planted area: 5,666,666ha (2006);
- Lint production: 6,646,000 tons(2006);
- About 40,000,000 farmers involved in cotton growing;
- 20,000,000 textile workers involved in cotton textile industry;
- Cotton importation: 2,560,000 tons to 3,640,000 tons in the past 3 years.

Figure.1 Cotton spinning spindles in China

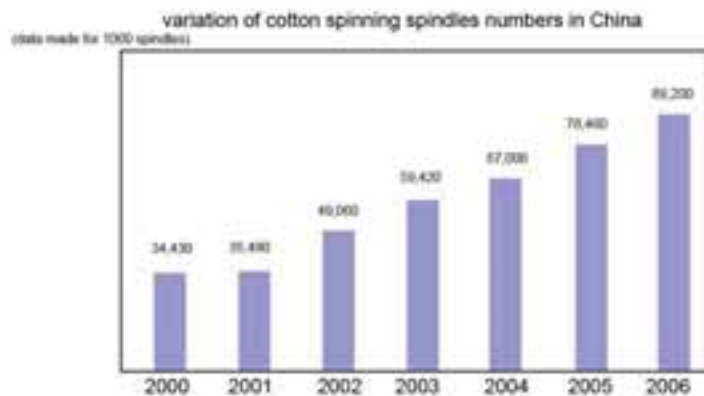
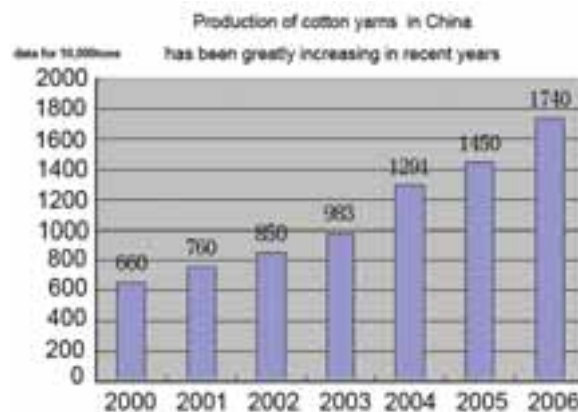


Figure 2 Production of cotton yarns in China



With 110 million cotton spinning spindles (according to information at beginning of 2008), we have a very clear picture of the capacity of Chinese cotton textile industry. Production of cotton yarns in China has been greatly increasing in recent years and its average increase has been about 18% since 2000

Bast fibres

Chinese farmers produce different kinds of bast fibres crops such as ramie, flax, hemp and kenaf, while textile processing capacity of bast fibres in general is doubtless also the number one of the world. Textiles made of flax and hemp are always present in top fashion design circles. But China still needs to import a lot of flax. The following data shows the general picture of agricultural and textile production, as well as importation of bast fibres in China.

The above data show the processing capacity of flax is larger, but agricultural production of flax in China can only supply 40% raw materials to factories.

Wool, silk, cashmere

In the last 20 years, China has had the largest wool textile industry, and about 76% of its wool has been imported from countries such as Australia, New Zealand, Uruguay, and

Figure 3 Bast fibres production and processing in China

Type Bast Fibres	Production in China (tonnes)	Processing amount (tonnes)
Ramie (refined)	113 500	110 000
Flax (scutched)	103 000	258 600
Hemp (refined)	4 000	4 000
Kenaf (retted)	158 000	158 000
Jute (retted)	0	29 000

Argentina Almost all silk textiles and cashmere textiles are made in China because Chinese farmers and goatherds supply the majority of these raw materials. The following data shows the production and textile processing of these animal fibres in China.

The above data shows that China can only supply 24 percent of the wool required by its factories and the rest (76%) has to be imported.

Figure 4 Wool, cashmere, raw silk production and processing in China

Type Bast Fibres	Production in China (tonnes)	Processing amount (tonnes)
Wool (scoured)	83 000	359 700
Cashmere	8 900	6 100
Raw silk	141 500	109 000

Both natural fibres and manmade fibres make an indispensable contribution to the quality of textiles. But it is very important to make consumers understand that using more natural fibres in clothing means not only more comfort but also a great contribution to mother nature.

R&D IN HEMP FIBRES PROCESSING TECHNOLOGIES

The birthplace of hemp is China. Archaeological discoveries show that we can backdate its self-sown growing to between 6,000 to 9,000 years ago. Archaeological specimens also show that, about 4,000 years ago, the Chinese people started widely growing the crop for food and clothing. Chemical analysis shows no THC in these specimens. About 3,000 years ago, hemp was introduced to India and then some mutative varieties of the plant appeared which have high content of THC and of course the variety with high THC content has other names as hashish or marijuana. In China, the growing of hemp is under the control of the Narcotics Control Bureau of the Ministry of Public Security. In recent years, China has developed Yunma 1 and Yunma 2 as varieties of very low THC content meeting the international standard for hemp.

Hemp and flax textile processing technologies are very similar, because the textile properties of hemp are very close to those of flax. Without a DNA check, even the most experienced textile expert can not tell the difference between flax fabric and hemp fabric. Pure hemp fashion fabric is made for niche markets with high value, but the quantity of the fibres used in this sector is limited. China’s textile processing capacity in general is enormous and especially for cotton. So we believe that developing hemp fibre processing technologies will blaze a new path and this will become a wide road that will facilitate the integration of hemp fibres into the cotton textile system, wool textile system, silk textile system, cashmere textile system and also for blending hemp fibres with manmade fibres. We believe this idea is correct in China because it will bring a brighter future for using hemp in textiles.

Cottonisation of hemp fibres

We cottonise traditional hard fibres from hemp into quite fine, soft and workable textile fibres nearly like cotton. One kilogram of textile fibres can be produced from 2 kgs of hemp bark.

Hemp viscose fibre

We also successfully make viscose fibres (both filament yarn and staple fibres) from hemp core hurd (shiv). Hemp rayon staple is ideal for cotton textiles. A very interesting point is that hemp viscose fibre has very strong anti-bacterial properties just like natural hemp fibres. This has been established both by our laboratory and by the laboratory of the Japanese company Asahi Kasei.

One kilogram of viscose fibres can be produced from 3 kgs of hemp core hurd.

Characters of hemp fibres

The inherent and special performance properties of hemp are very important in the market because they are attractive selling points of hemp textiles to consumers. Following are the major functional qualities of hemp fibres.

In Contrast with cotton, hemp has the best quality of moisture (sweating) absorption and dispersion. Very high adsorbability to toxic gases of hemp is an excellent attraction for household textiles.

How to cottonise hemp fibres

By a group of degumming technologies, we cottonise hemp fibres. We developed some new technologies and machines to process hemp into fibres for the cotton system as well

Figure 5 Hemp fibre

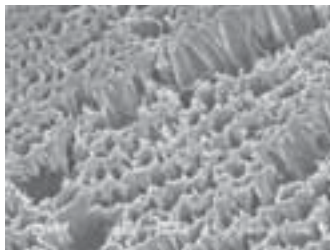


Figure 6 Properties of hemp fibre

Specifications	Unit	Hemp	Cotton
Fiber length	mm	20-25	25-31
Fineness	tex	0.22-0.38	0.12-0.20
Tenacity	N.tex	>0.48	0.22
Breaking elongation	%	2.2-3.2	7.12
Young's modul	N.tex	16-21	6.00-8.20
Heat resistance	Deg centigrade	370	190
Moisture absorption	Mg/min	2.18	1.33
Moisture dissipation	Mg/min	4.4	2.37

Natural Anti-bacterial Quality of hemp

Figure 7 Test results show that hemp fibres repress Nosocomial germs

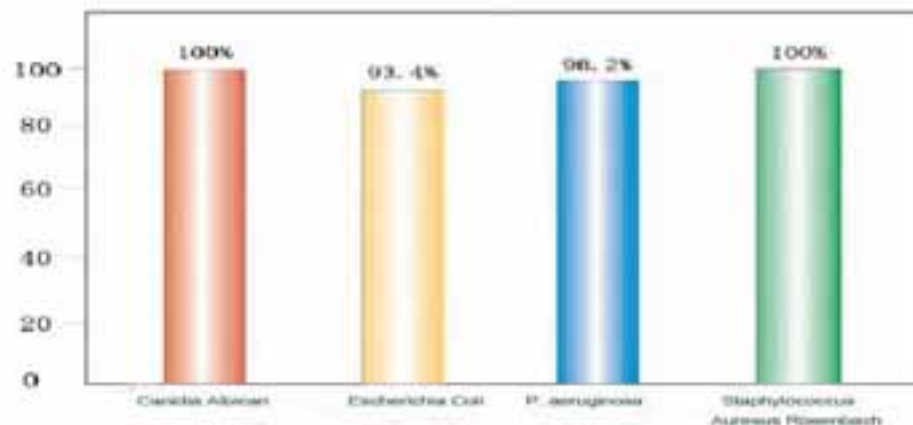
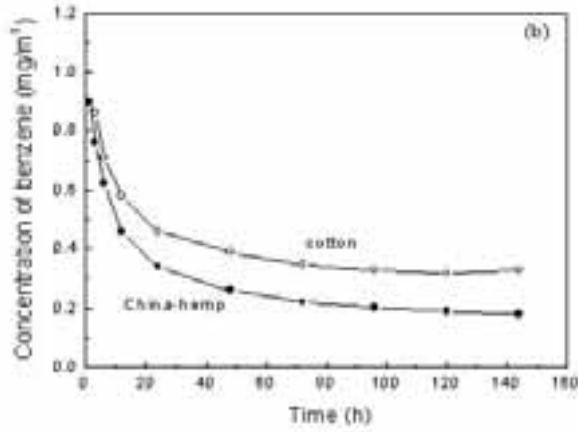


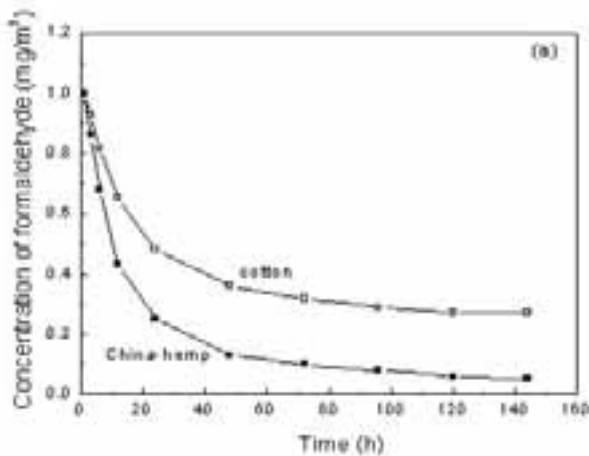
Figure 8 Adsorbability to formaldehyde of hemp and cotton



Unique adsorbability

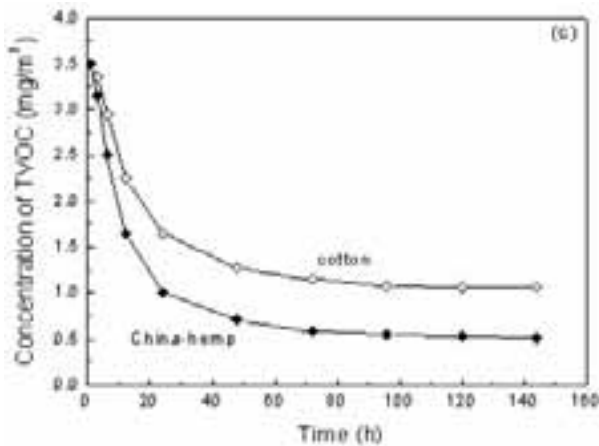
Formaldehyde adsorbing capacity of hemp is 9-10 times higher than that of cotton

Figure 9 Adsorbability to benzene of hemp contrasted to cotton



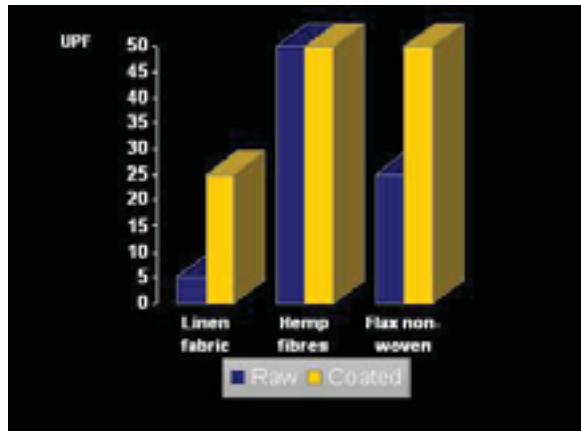
Benzene adsorbability of hemp is 6-7 times higher than that of cotton

Figure 10 TVOC adsorbability of hemp contrasted to cotton



TVOC adsorbability of hemp is 6-7 times higher than that of cotton.

Figure 11 UV Resistance of hemp



UV Resistance of Hemp is excellent

as for the wool system and for blending with man-made fibres. The following photos show some machines we developed.

Why we make hemp viscose fibres

Viscose fibre made from hemp hurd (shiv) is a special type of functional viscose fibre. And it makes economic sense to use this non-food crop as raw material for industry.

The usual raw material for producing viscose fibre in China is linters. But we can successfully make viscose from hemp core hurd. By using hemp for viscose production:

1. The shortage of supply of linters in China can be overcome;
2. The cost of viscose can be decreased;
3. Also farmers benefit more

Hemp viscose fibre has also very good resistance to UV; therefore fabrics made by hemp viscose will have much stronger UV resistance than viscose made from linters.

Our test shows that hemp viscose has anti-bacterial character similar to the fibres extracted from hemp bark

Figure 12 Cottonisation of hemp fibres

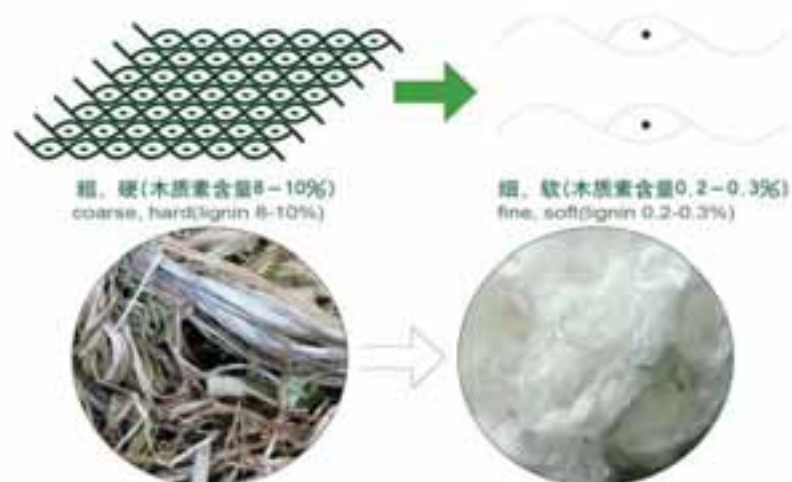


Figure 13 machines that have been developed



Figure 14 machines that have been developed



Figure 15 machines that have been developed



HEMP AGRICULTURE AND HEMP INDUSTRIES CONTRIBUTE TO FOOD SECURITY

Hemp agriculture: benefits for Food Security

Hemp is the greenest crop that requires only very poor soil. In China growing hemp is possible in almost all places. We have summarized the following benefits and these make a strong argument for improving food security in China.

Figure 16 specification of viscose staple fibers made by hemp core hurd

Item	Spec	Origin	Colour	Dry denacity cN/dtex	Wet tenacity cN/dtex	Dry elongation %	Luster
1.5d x 38	1.67 x 38	China	White	2.49	1.53	22.31	Bright
3d x 62	3.34 x 62	China	White	2.44	1.41	25.72	Bright

Cotton growing needs correct soil conditions and a great amount of pesticide must be used

Hemp can be grown in much poorer soil and requires much less pesticide, which is a contribution to the protection of soil and environment.

If 1,333,333 ha. of hemp is grown, China can reduce its area of cotton by the same amount, which means this 1,333,333 ha. can be used for growing food crops!

Our great plan is to grow 1,333,333 ha. of hemp to produce 2,000,000 tons of fibres for China textile industry

The main crops in the plains of northern China are soybean and wheat; hemp is the best choice for rotation crops - farmers make better use of their lands and make more money at the same time.

The map in fig 17 shows that major cotton growing regions are also the same regions where major food crops such as rice and wheat grow.

In the map of Fig 18, the green coloured parts are the regions where we plan to grow 1,333,333 ha. of hemp. Hemp will not displace food in the regions, because in some cases they are not major food growing areas, and in others hemp will be ideal as rotation crop.

Figure 17 cotton growing regions in China



Full use is made of the hemp plant

Not only fibres are used from the hemp plant, but full use is made of all parts of this crop for different industries and applications.

Fig.18 hemp growing regions in China



- Hemp core hurd(shiv) is used for wood plastic composite and activated carbon
- Hemp seed is used for edible oil, healthcare oil, cosmetics & lotions
- Hemp leaves and flowers are used to produce medicines
- Hemp roots will not be thrown away but used as combustibles

Fig 19 shows the hemp wood plastic product used

as outdoor flooring boards in 2008 Olympic Park

CONCLUSION:

As we can see from above description, hemp is indeed an ideal non-food crop for China, because both agricultural production and industrial production benefit a lot from this crop, and it contributes so much to improvement of the environment and the food security of our nation. We can summarize following major points as the conclusion.

Figure19 Application of hemp WPC boards



- Farmers living on hills and uplands as well as semi-arid, and poor soil places will profit from growing hemp
- Our country will have more places to grow food crops and environment

will be also improved

- Industries will also have benefits in developing eco-friendly products with more useful functions

Coir fibre in Asia

Romulo Arancon, APCC, Jakarta



OUTLINE

- I. Unique Properties of Coir
- II. Coir Products and Uses
- III. Coir Fibre and Coir Pith Resources
- IV. World Coir Export and Prices
- V. Emerging Applications of Coir Products
- VI. Challenges in the Coir Industry Towards Reducing Poverty and Promoting Employment and Income

I. Coir, the product extracted from husk has unique properties compared to other natural fibres in several ways:

- It is the thickest and most resistant of all commercial natural fibres.
- Its cellular structure makes it more elastic than other natural fibres.
- The cell – walls of coir fibre and pith contain more lignin than any other commercially relevant natural fibre.
- Lignin is a natural polymer, which adds strength and elasticity to the cellulose based fibre walls. Since lignin resists bio-degradation, a high lignin content also imparts longevity to outdoor applications.

II. COIR PRODUCTS AND USES

Coir's properties have made it the fibre of choice for several uses:

- General purpose **twine** and **rope** in producing countries, where these products are a common sight in roadside stalls.

II. COIR PRODUCTS AND USES

- **Brooms** and **Brushes** : from hand brushes to the metal wire twisted tawashi brushes used in the kitchen. This sector is another area where the stiffness and durability of coir make it a natural choice with limited competition, even by synthetics.

II. COIR PRODUCTS AND USES

- Almost indestructible, scrubby and increasingly stylish **doormats** and a wide range of designs of double **rugs**.
- No other natural fibre makes better doormats yet synthetics always loom as a competitor. Manufacturers try to maintain a role for coir by offering softer rugs made from blends of coir and other tropical fibres, such as sisal and jute, in a range of designs.

II. COIR PRODUCTS AND USES

- **Mattresses**, **upholstery**, **car seats**, often as **non-woven mats** sprayed with natural latex (rubberized coir). In India and China, particularly the demand for more "sleeping comfort" has reignited the market.

II. COIR PRODUCTS AND USES

- **Car seat** covers are still found in several high-end European car models. Rubberized coir is also making inroads as durable flowerpots.

II. COIR PRODUCTS AND USES

Coir Waste and Dust (Pith)

- While extracting coir fibre, the short fibre (2mm or less) and dust (pith) are left behind as a waste product.
- Coir dust or coconut peat is a good planting medium with excellent water holding capacity (up to 8 to 9 times its dry weight).




GEOTEXTILES AND ORGANIC PLANTER POTS

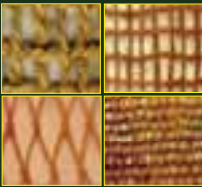
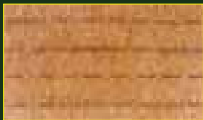
- Technological advances in bioengineering and urgent need to rehabilitate degraded lands, slopes led to development of new applications of coconut coir.
- **Coir nets/geotextiles, coco rolls or biologs** are used for environmental protection – erosion control (desertification in China).
- These products are preferred due to strength, ecological qualities and biodegradability.

COIR GEOTEXTILES (COIR BHOOVA STRA)



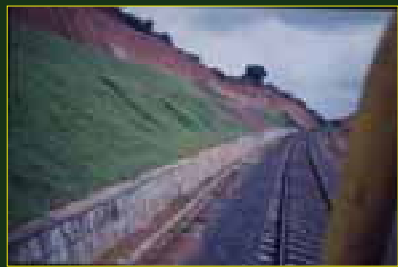

Cocolog Coir needled felt

COIR GEOTEXTILES (COIR BHOOVA STRA)

Coir netting Erosion control blanket

COIR GEOTEXTILES (COIR BHOOVA STRA)



Railway embankment protection



COIR GEOTEXTILES (COIR BHOOVA STRA)






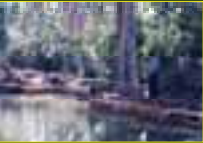
Prevent soil erosion in the slopes / embankments of road.

COIR GEOTEXTILES (COIR BHOOVA STRA)

River bank protection Reservoir bank protection

COIR GEOTEXTILES (COIR BHOOVA STRA)

Mud wall reinforcement Stream bank protection


GARDEN ARTICLES FROM COIR

Coconut planter pots as soil-less potting medium from coir dust which can hold water at least twice its own weight.



Coco pots Coir Hanging Basket

GARDEN ARTICLES FROM COIR



Creepers poles Coir Basket

GARDEN ARTICLES FROM COIR



Coir Pith Bricks


COCOLAWN™



Cocolawn, a ready to use lush green natural lawn made from coir geo textiles, coir non woven felt, coir pith and composted coir pith on which the lawn grasses could be planted.

SOFTENED COIR PRODUCTS

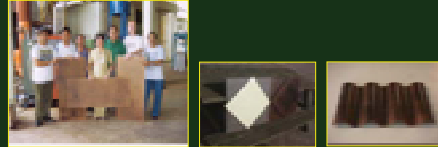
Cushions / pillows / mats were developed from softened coir fibre which has supple feel. The softened fibre do not induce skin sensitisation in guinea pigs and it is non-irritant to the mucous membrane in rabbits.



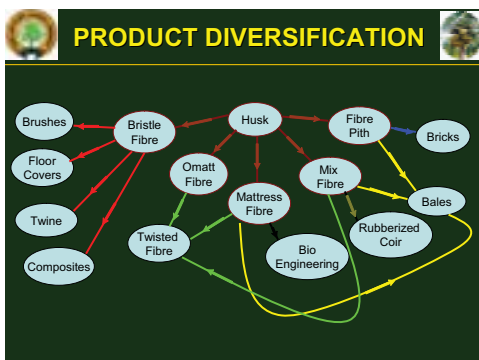
Cushion Seat cushions for school children Softened coir pillow

BINDER – LESS FIBER BOARD FROM COCONUT HUSK (ECOCOBOARD)


- PCA – ATO – DLO – CFC – FPRDI developed the production process of fiberboard using natural lignin content of coconut husk.



- Can be used as construction materials, molded 3D furniture parts & accessories & as packaging material for machineries.




COIR MATTRESS FIBRE




Mattress Fibre Bales For Mattresses

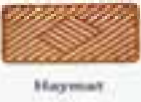
COIR BRISTLE FIBRE



Bristle Fibre



Daisy



Haymat

For Carpets

COIR BRISTLE FIBRE



Bristle Fibre



Boot Wiper Brushes



For Brushes

COIR TWISTED FIBRE



Black Dyed Coils



Twisted Fibre Natural Coils




For Car Seat


COIR TWINE



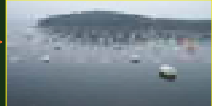
Coir Twine in Hanks



Coir Twine in Roll




For Hop Industry




For Oyster Cultivation


COIR TWINE




Carpet Twine



Garden Twine



For Floor Coverings



For Horticulture

RUBBERIZED COIR/COIR POTS



Rubberized Coir



Coco Pots for Commercial Gardening



Liners for Hanging Baskets

WOVEN GEOTEXTILES




Geotextile Roll




For Erosion Control




STITCHED BLANKETS



Stitched Blanket Roll



For Soil Erosion Control



For River Bank Protection

COIR FIBRE PITH

As a Growing Media

USES OF COCOPEAT & HUSK SUBSTRATE

- Growing media in the Green House Industry
- Sold in the Garden Centers as potting soil
- Alternative to Peat moss in Soil less cultivation
- Used in landscapes

III. GLOBAL COCONUT PRODUCTION AND POTENTIAL AVAILABILITY OF COIR FIBRE AND COIR PITH

- Coconuts is grown in more than 93 countries in the world, in an area of about 12.05 million ha and produce 61,165 million nuts.
- The Asia and Pacific countries alone produce 52,936 million nuts.

Table 1. Global Coconut Production and Potential Availability of Coir Fibre and Coir Pith at 50% Available Husks

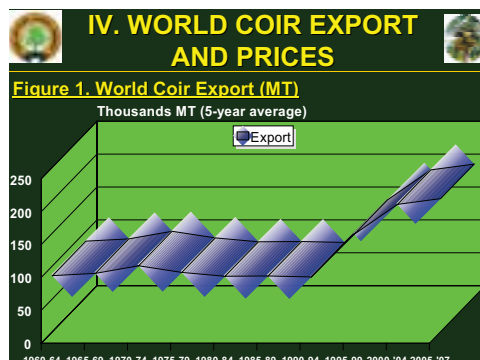
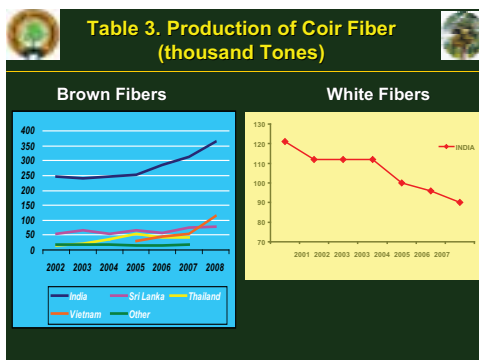
	Total Nut Production (million)	At 50% availability of husks (million tonnes)	
		Fibre	Coir pith
World	61,165	3.67	8.5
Asia – Pacific	52,936	3.17	7.4
APCC Countries	50,577	3.03	7.1
Africa	2,187	0.13	0.30
American	6,047	0.36	0.84

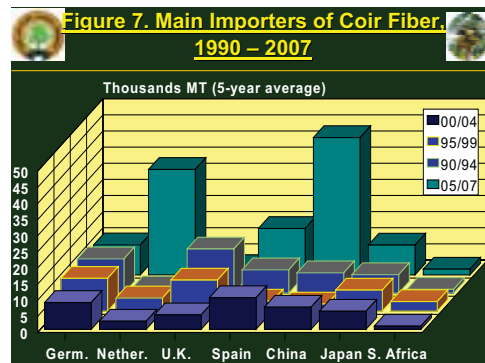
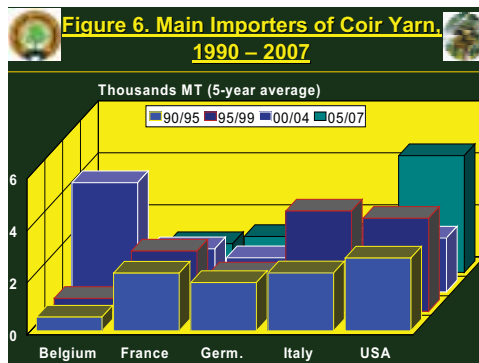
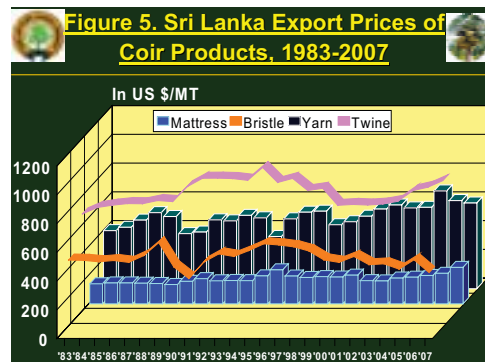
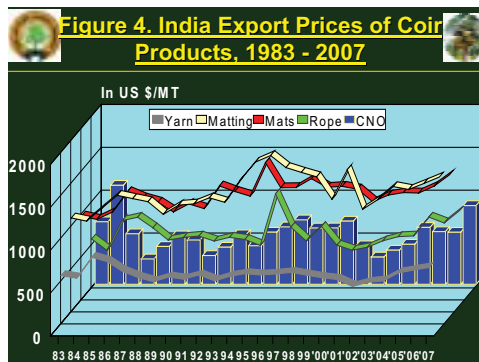
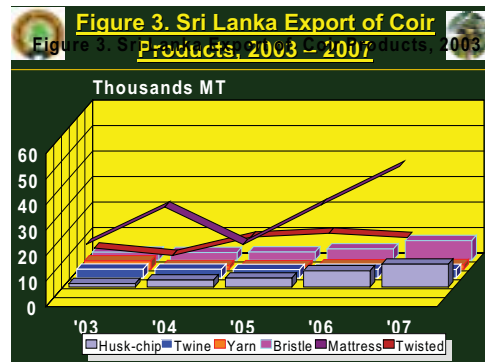
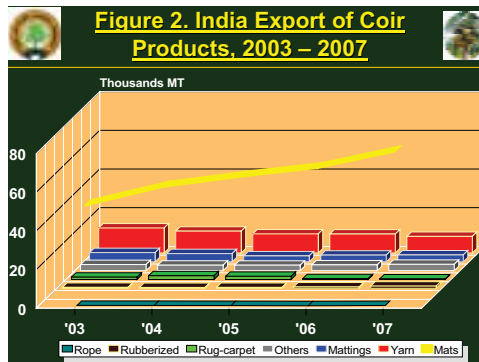
Assumption Husk : 400 gram
Fibre : 120 gram (30%)
Coir dusk & shorts : 280 gram (70%)

- While 93 countries are growing coconuts, India and Sri Lanka are the major producers of coir and coir products.
- The production of coconut in major Asian countries and the potential availability of coir fibre and pith are given in table 2.

Table 2. Coconut Production in Asian and Pacific Countries, Potential Availability of Fiber (at 50% of Available Husk)

Country	Production of Nuts (Million)	At 50% Available Nuts for Husking	
		Fiber (Thousand Ton)	Coir Pith (Thousand Ton)
1. F.S. Micronesia	40	2.4	5.6
2. Fiji	150	9.0	21.0
3. India	12,160	729.6	1,702.4
4. Indonesia	19,537	1,172.2	2,735.2
5. Kiribati	53	3.2	7.4
6. Malaysia	400	24.0	56.0
7. Marshall Islands	41	2.5	5.7
8. Papua New Guinea	712	42.7	99.7
9. Philippines	12,456	747.4	1,743.8
10. Samoa	190	11.4	26.6
11. Solomon Islands	110	6.6	15.4
12. Sri Lanka	2,591	155.5	362.7
13. Thailand	1,199	71.9	167.9
14. Vanuatu	258	15.5	36.1
15. Vietnam	680	40.8	95.2
Total	50,577	3,034.7	7,070.8





V. EMERGING APPLICATIONS OF COIR AND COIR PITH

- Natural fibres as reinforcements in industrial products have made considerable headway in the automotive interiors especially in Europe for reducing cost and weight.
- Several European firms are testing whether coir can play a role in a growing automotive market for "bio composites", or as thermal insulation in home construction.

V. EMERGING APPLICATIONS OF COIR AND COIR PITH

- Coir fibre products for soil strengthening as reinforcement in tropical soils has been shown to be effective.
- In horticulture sector, natural fibre can play a vital role (with reasonable strength and disposability in transporting flowers, vegetables, fruits, etc. pots for planting).


V. EMERGING APPLICATIONS OF COIR AND COIR PITH

- In the Netherlands about 2 million pots of plants are produced consuming about 30,000 tonnes of synthetic plastics. Biodegradable pots using natural fibres can be produced replacing synthetic plastics.



V. EMERGING APPLICATIONS OF COIR AND COIR PITH

- Use of coconut fibres in asphalt and unpaved rural roads can be tested on pilot scale for bulk utility.
- Rubberized coir used to be the material of choice for car seats, but largely lost out to competition from synthetic foams. Yet, the remaining use of coir in several high-end European car models is an example of how natural fiber products can stay competitive and possibly regain ground.




V. EMERGING APPLICATIONS OF COIR AND COIR PITH

- Geotextiles – made out of coir fibre is an important ecofriendly product which is gaining market in Europe, Asian and US countries as erosion control blankets, nets for slope protection, mulch blankets, basket linens, 'coir bio roll', roof greening mat, grow sticks, coco logs, grow media as well as skeffed coir for river bank / canal bank support.



V. EMERGING APPLICATIONS OF COIR AND COIR PITH

- Low cost wall panels from Blast Furnace Slag Cement using coir fibres have been developed in Brazil as a low cost environmental sensitive technology. This technology is available in the Institute de Pesquisas Technologicas do Estado de Sao Paulo S.A., Brazil.
- High-tech products of industrial textiles is also possible and needs to be exploited by importing coir fibre.



V. EMERGING APPLICATIONS OF COIR AND COIR PITH


- Ecocoboard has been successfully produced from coconut husk and have a wide scope for commercialization for use in mass housing.



VI. CHALLENGES IN THE COIR INDUSTRY TOWARDS REDUCING POVERTY AND PROMOTING EMPLOYMENT AND INCOME

- For about 150 years, the coir industry is still practicing traditional ways and many do not have facilities for workers and is not hygienic.


- Improving the working conditions will help to increase the efficiency of labor. Especially the large number of women who are involved in traditional fiber extraction.



VI. CHALLENGES IN THE COIR INDUSTRY TOWARDS REDUCING POVERTY AND PROMOTING EMPLOYMENT AND INCOME

- Integrated farm level processing as a community/cooperative approach will facilitate greater availability of husk in a particular place rather than what individual smallholders are doing in a scattered way.

Besides providing large quantity of husk, this will also provide additional employment and income to the farming family. (Aggregator or consolidator's concept)



VI. CHALLENGES IN THE COIR INDUSTRY TOWARDS REDUCING POVERTY AND PROMOTING EMPLOYMENT AND INCOME

- Improve efficiencies of production and processing should include improved agronomic practices to increase coconut production and ensure food security.

- An increase in the productivity will increase the raw material availability.
- Improving the processing efficiency and quality have remained to be a challenge.



VI. CHALLENGES IN THE COIR INDUSTRY TOWARDS REDUCING POVERTY AND PROMOTING EMPLOYMENT AND INCOME

4. New and improved products should be developed especially in applications where natural fibres have advantage over synthetics.

- Among these are geotextiles, carpeting, wall covering, wire rope cores, composites, ecocobboards and packaging materials.



VI. CHALLENGES IN THE COIR INDUSTRY TOWARDS REDUCING POVERTY AND PROMOTING EMPLOYMENT AND INCOME

5. Use of coconut husk, for making grow bags using cut fibre, husk chips and coir pith has potential market in horticulture and for growing vegetables and ornamental plants, flower plants, etc. However, the quality standards for these products have to be maintained (**salt content**).



VI. CHALLENGES IN THE COIR INDUSTRY TOWARDS REDUCING POVERTY AND PROMOTING EMPLOYMENT AND INCOME

6. Strengthening the institutional capabilities of coconut growing countries so as to enable them to undertake their own research and development activities on husk utilization.



VI. CHALLENGES IN THE COIR INDUSTRY TOWARDS REDUCING POVERTY AND PROMOTING EMPLOYMENT AND INCOME

7. Since many of the developing countries growing coconuts are not utilizing coconut husk to produce value added products, providing such facilities can go along way to provide employment, increase the income of coconut farmers and reduce poverty.

- There is a need to develop institutional capabilities or capacity building.

New Technologies for Fibre Extracting



Decorticator
Capacity : 3.2 tons fibre output / 8 hrs

VI. CHALLENGES IN THE COIR INDUSTRY TOWARDS REDUCING POVERTY AND PROMOTING EMPLOYMENT AND INCOME

- A good example is the CFC-funded project in Sri Lanka where an R & D and Training Center in a rural area is set-up to demonstrate **improved work conditions** and **best practices** in coir processing.



New Technologies for Geotextile Manufacturing



VI. CHALLENGES IN THE COIR INDUSTRY TOWARDS REDUCING POVERTY AND PROMOTING EMPLOYMENT AND INCOME

- This facility will also demonstrate **standards for quality assurance**, **improved the efficiency of machineries used**, **develop skills of operators** and prove that **productivity and profitability** can be achieved.

New Technologies for Floor Carpet Manufacturing



New Technologies for Floor Carpet Manufacturing




Fibres can be classified into two main groups: man-made and natural. In general, natural fibres can also be subdivided as to their origin: plants, animals, or minerals. The natural/vegetable/plant fibres, which are the main type of fibres discussed here, can be further subdivided into seven subgroups, such as bast fibres, leaf fibres, seed fibres, fruit fibres, and wood fibres, as shown in Figure 1. Further commercially important fibre types along with their world production levels are presented in Table 1.

Table 1. Commercially important natural fibres

Fibre	Main Countries	Origin	World Production 2004 (tonnes)
Wood	Various (>10,000 species)	Stem	1,750,000,000
Bamboo	China (>1250 species)	Stem	10,000,000
Jute	India, Bangladesh	Stem	2,861,000
Kenaf	India, China	Stem	970,000
Coir	India, Vietnam, Sri Lanka	Fruit	931,000
Flax	China, Europe	Stem	830,000
Sisal	Brazil, Tanzania, Kenya	Leaf	378,000
Ramie	China	Stem	249,000
Hemp	China, Europe	Stem	214,000
Abaca	Philippines, Ecuador	Leaf	98,000
Agave	Columbia, Cuba, Mexico	Leaf	56,000

Figure 1 also shows examples of each classification, for example, the bast fibre subgroup includes fibres of the flax, hemp (Figure 2), jute, and kenaf plants, to name but a few. Bast fibres provide a good reinforcement in composite materials as the bast fibres task is to act as a reinforcement within the plant and provides stability. Using leaf fibres gives improved toughness and incorporating seed or fruit fibres imparts elastomeric type toughness to the component in question.

Figure 2. Industrial Hemp growing in China (Photo taken by the author on a visit to China in 2001)



A number of reasons for the increase in natural products can be cited, such as, recent concerns over dwindling petroleum supplies and their ultimate exhaustion in the distant future; increased government legislation such as land fill taxes; and a greater emphasis on sustainability and biodegradability. In short, there is a need to be seen to be using 'greener' products and processes.

In parallel to the increased awareness of natural materials as potential feed stocks for industrial products, there has been a great political drive towards sustainable technologies. Western governments have been seeking polymer materials

which are not reliant on crude oil; seeking lighter weight materials which can reduce carbon emissions by reducing vehicle weight; seeking natural insulation materials to improve energy efficiency of buildings; seeking carbon sinks such as forests (and forest products – timber) to lock up carbon dioxide; seeking recyclable or compostable materials which can reduce the landfill crisis. These policies have given a considerable “push” to the research community, with many interesting results.

INDUSTRY SECTOR APPLICATIONS

Composites currently occupy many market sectors of which a number are suited to the introduction of natural fibre composites as an alternative. Currently, the largest areas in which natural fibre composites are being employed include the automotive and construction industries.

Fibre quality for high end applications is often proportional to cost, for example the strongest flax fibre is slightly more expensive than glass due to competition with the textile industry, but lower grades of flax from linseed oil production are less expensive. The relative costs of other natural fibres such as jute, coir, sisal, hemp are considerably lower than glass, and vary with proximity to market and various agronomic factors between regions.

Production costs are reported to be reduced by 10-30% when natural fibres are used in place of glass fibre. The use of conventional processing methods means there is no need for new processing equipment and the equivalent processing conditions make transfer to this alternative feedstock very simple. Natural fibres are a good candidate fibre to use in products where traditionally glass fibres have been used. It is estimated that there are some 2.3 million tonnes of glass fibres being used in various applications around the globe, so there are a number of opportunities for natural fibres to be used in place of existing glass fibres. Natural fibres have several advantages over glass fibre: low density, low cost, high toughness, acceptable specific strength properties, good thermal properties, low embodied energy, reduced tool wear reduced tool wear in the moulding process and have better acoustic properties thereby reducing cabin noise, reduced irritation to the skin and respiratory system, and they also have a low energy requirement for processing. In addition they are biodegradable or recyclable depending on the selected matrix.

The biodegradable polymer matrices are still considerably higher priced than the “big four” thermoplastics (PE, PP, PS and PVC), although the costs have in general fallen during the last ten years as industrial production has scaled up. The costs are now roughly equivalent with the costs of more specialist polymers such as polycarbonate.

If we address a few of the main industrial sectors highlighted above we can see what has been showcased as the most recent developments in these sectors.

AUTOMOTIVE INDUSTRY

In the early 1930's, Henry Ford examined a variety of natural materials including cantaloupes, carrots, cornstalks, cabbages and onions in a search for potential candidate materials from which he could build an organic car body. He developed a prototype based on Hemp but due to economic limitations at that time the vehicle was not mass produced. Interest in natural materials diminished with the advent of other more durable materials, such as metals, and it was not until the 1940's that natural fibres began to make a comeback¹. Ford scientists discovered that soybean oil could be used to make high quality paint enamel and could also be moulded into a fibre based plastic². The company claimed that the material had 10 times the shock-resistance of steel. Henry Ford

delighted in demonstrating the strength of the material by pounding the soybean boot lid with an axe. If it was not for the fact that the material required a long cure time, and did not suffer from moulding problems, we might well be driving cars made from this material today.

Composites, particularly natural fibre reinforced plastics, have been receiving increased attention since 1941 in other industries such as the aerospace and marine industries³. The composites were used for making seats, bearings and fuselages in aircraft and for bearings in ships⁴. One particular example is that of "Gordon-Aerolite", a composite of unidirectional, unbleached flax yarn impregnated with phenolic resin and hot pressed. This was used in aircraft fuselages during World War II when materials supplies were restricted⁵. Cotton-polymer composites were reported to be the first fibre reinforced plastic used by the military for aircraft radar^{6,7}.

In the 1950's the body of the East German Trabant car was the first production vehicle to be built from natural Fibres, Cotton was used embedded within a polyester matrix⁸. These cars were still in production up until 1990, and can still be seen on the roads of Eastern European cities today.

Later, in the 1980's the first use of natural fibre and bio resin was used in combination to create the first all bio-composite automotive door panel. In the 90's, Daimler-Benz pioneered the use of natural fibres in commercial vehicles as part of the 'Belem' project based in the Amazon delta in South America. In this application, coconut fibres were used with latex in trucks for around a nine year period, with backrests, head restraints, bunk cushions and sun visors being produced, demonstrating the potential that indigenous fibres can have for a country and how they can be used in a commercial application in the automotive industry. This not only improved the quality of life for the individuals involved in this new application but it also became a commercial success and ensured its continuation.

Coconut fibres have been used in cars for more than 60 years in such applications as interior trim and seat cushioning. Estimated service life for these products is around 90 years – well exceeding the lifespan of the intended application⁹. Unlike plastic foam, the coconut fibres have good 'breathing' properties which is a distinct advantage for vehicle seats being used in countries where the climate is hot, as is the case in Brazil. Coconut fibres are also naturally resistant to fungi and mites and the remains of the fibres also make an effective natural fertilizer at the end of their lifetime⁹. In 1994, Daimler Chrysler started using flax and sisal fibres in the interior trim components of its vehicles. They continued investing in their application of natural fibres and in 1996 Jute was being utilised in the door panels of the Mercedes Benz E- Class vehicles. Daimler Chrysler as a company investing in environmental initiatives are a good example to cite here. In 2000, they spent around \$1.5bn on environmental initiatives of which \$870m was spent on environmentally friendly products and production processes resulting in a plethora of natural based components for their entire range of vehicles. German Car manufacturers are aiming to make every component of their vehicles either recyclable or biodegradable¹⁰.

Nowadays, there is an increasing trend for the use of natural fibres as a result of government legislation on environmental issues. This is particularly important in those countries where products from agricultural sources offer an attractive and cheap alternative for developing degradable materials¹¹. However, their potential use as a reinforcement is greatly reduced because of their hydrophilic (water absorbing) nature¹², and the lack of sufficient adhesion between untreated fibres and the polymer matrix¹³ resulting in poor impact resistance of the products. The issue of poor interfacial adhesion between fibres and matrix material is due to a mismatch in surface polarities – cellulose (polar) and polyolefins (non polar),

these issues have been addressed by the development of effective surface treatments¹⁴ for the fibres in both physical (Cold plasma and Corona) and chemical treatments (malaeic anhydride and organosilanes etc.). If a composite exhibits poor adhesion then it is going to be more susceptible to environmental attack and ultimately a reduced life span. As a result, considerable effort is currently being directed towards optimising the mechanical performance of fibre reinforced composites, and in particular their durability, through optimisation of the interfacial bond between the fibres and the polymer matrix¹⁵. Another issue in relation to poor impact properties is due to the high concentration of fibre defects imparted to the fibres in many cases during the mechanically intensive harvesting and processing stages which must also be addressed for improved product performance.

THE EUROPEAN AUTOMOTIVE INDUSTRY

The nature of the car industry (manufacturers, suppliers and legislation etc.) means it is necessary to look at the issue of these novel materials from a European perspective. The majority of examples quoted here relate to European based activities, clearly there are a number of other examples worldwide which warrant attention, however, this review covers developments within the European automotive industry predominantly. One of the most important sectors to have adopted natural fibres in recent years has been the European automotive. The second largest sector where these materials find use is in the construction industry¹⁶. It is also interesting to note that the situation in the United States (U.S.) is reversed. It is the construction sector which consumes the greater share of the natural fibre market at 64%, whilst the U.S. automotive industry has only a 16% share of the natural fibre market¹⁷. The United States automotive industry lags behind Europe by some 7 years.

A study conducted in 1999¹⁸ indicated that up to 20 kg of natural fibres could be used in each of the 53 million vehicles being produced globally each year. This means that for each new model of car there would be a requirement of between 1,000 and 3,000 tonnes of natural fibres per annum, with some 15,000 tonnes of flax being used in 1999 in the European automotive industry alone. To the natural fibre producer, the automotive market is attractive as a vehicle models platform life is for a minimum of 5 years but more realistically 7-8 years. This ensures a sustained period of demand for the natural fibres and helps to establish a period of credibility for the natural materials.

A study by the Nova Institute in 2000¹⁹ reviewed market possibilities for the use of short hemp and flax fibres in Europe. In this study, a survey of German flax and hemp producers showed that 45% of hemp fibre production went into automotive composites in 1999. One of the attractions of hemp, as compared with flax, is the ability to grow the crop without pesticide application. The potential for fibre yield is also higher with hemp.

Current well-established applications of natural fibres in automotive vehicles (Table 2).

The schematic of a generic vehicle, Figure 3, shows current applications from a range of different manufacturers. The type of natural fibre selected for manufacture is influenced by the proximity to the source of fibre, thus panels from India and Asia contain jute, ramie and kenaf, panels produced in Europe tend to use flax or hemp fibres, panels from South America tend to use sisal, curaua, and ramie.

The typical weight of natural fibres used within various parts of a vehicle are shown in Table 3:

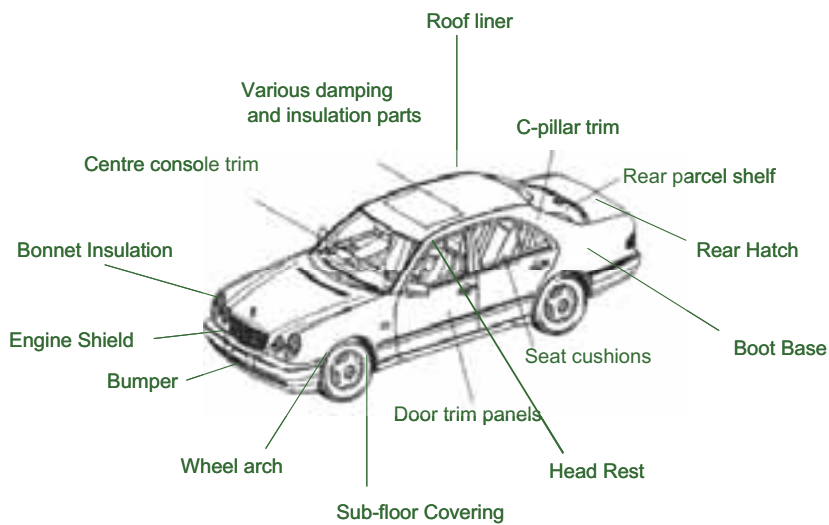
Virtually all of the major car manufacturers in Germany (i.e., Daimler-Chrysler, Mercedes, Volkswagen Audi Group, BMW, Ford and Opel) now use natural fibre composites in

Table 2. Vehicle manufacturers and use of natural fibre composites. ¹

AUTOMOTIVE MANUFACTURER	MODEL APPLICATIONS
AUDI	A2, A3,A4 (& Avant), A6, A8, Roadster, Coupe Seat backs, side and back door panels, boot lining, hat rack, spare tyre lining
BMW	3,5,7 series Door panels, headliner panel, boot lining, seat backs, noise insulation panels, moulded foot well linings
CITROEN	C5 Interior door panelling
DAIMLER-CHRYSLER	A, C, E and S-class models, EvoBus (exterior) Door panels, windshield, dashboard, business table, pillar cover panel
FIAT	Punto, Brava, Marea, Alfa romeo 146, 156
FORD	Mondeo CD 162, Focus Door panels, B-pillar, boot liner
LOTUS	Eco Elise (July 2008) Body panels, Spoiler, Seats, Interior carpets
MERCEDES-BENZ	TRUCKS Internal engine cover, engine insulation, sun visor, interior insulation, bumper, wheel box, roof cover
PEUGEOT	406 Seat backs, parcel shelf
RENAULT	Clio, Twingo Rear parcel shelf
ROVER	2000 and others Insulation, rear storage shelf/panel
SAAB	Door panels
SEAT	Door panels, seat backs
TOYOTA	Brevis, Harrier, Celsior, Raum Door panels, seat backs, Spare tyre cover
VAUXHALL	Corsa, Astra, Vectra, Zafira Headliner panel, interior dorr panels, pillar cover panel, instrument panel
VOLKSWAGEN	Golf, Passat, Bora Door panel, seat back, boot lid finish panel, boot liner
VOLVO	C70, V70 Seat padding, natural foams, cargo floor tray

applications such as those listed in Table 2. Ford uses from 5 to 13 kg (these weights include wool and cotton)²². The car manufacturer, BMW, has been using natural materials since the early 1990's in the 3, 5 and 7 series models with up to 24kg of renewable materials being utilised. In 2001, BMW used 4,000 tonnes of Natural fibres in the 3 series alone. Here the combination is a 80% flax with 20% sisal blend for increased strength and impact resistance. The main application is in interior door linings and panelling. Wood fibres are also used to enclose the rear side of seat backrests and cotton fibres are utilised as a sound proofing material.

Figure 3. Components on a generic vehicle, made from natural fibre composite materials²⁰



In 2000, Audi launched the A2 mid-range car which was the first mass-produced vehicle with an all-aluminium body. To supplement the weight reduction afforded by the all-aluminium body, door trim panels were made of polyurethane reinforced with a mixed flax/sisal mat. This resulted in extremely low mass per unit volume and the panels also exhibited high dimensional stability.

Recently, in the last few years, Volvo have started to use Soya based foam fillings in their seats along with natural fibres. They have also produced a cellulose based cargo floor tray – replacing the traditional flax and polyester combination used previously which resulted in improved noise reduction ²³.

Toyota has been using increasingly more natural fibres in their components since 1999²⁴, in the range of their vehicles such as in the Celsior, Brevis and Harrier. Kenaf fibres used in board production along with Polypropylene is the composite of choice for door trims, manufactured at Toyota’s Indonesian production facility. What is interesting to note in this case is that the three vehicle models mentioned above adopted the natural fibre components within a relatively short time frame of 4 years for the three models. Toyota also claim to have manufactured the first mass produced 100% natural automotive product in the world back in May 2003 namely the RAUM spare tyre cover which is comprised of Kenaf fibre and Polylactic acid or PLA as it is commonly known. Lactic acid-

based polymers (polylactides) are polyesters made from lactic acid, a compound found in both plants and animals.

Table 3. Natural fibre usage per component²¹

Component	Weight (Kg)
Front door liners	1.2-1.8
Rear door liners	0.8-1.5
Boot liners	1.5-2.5
Parcel Shelves	<2
Seat Backs	1.6-2
Sunroof shields	<0.4
Headrests	2.5

The present level of car production in Western Europe is about 16 million vehicles per year. This figure therefore equates to a current usage of 80,000 to 160,000 tonnes of natural fibre per year. German automotive manufacturers continue to lead the way, with Daimler-Chrysler for example, having a global natural fibre initiative program that benefits third world nations by developing products made from indigenous agricultural materials.

The Mercedes-Benz Travego travel coach, is equipped with flax reinforced engine and transmission covers. This was the first use of natural fibres for standard exterior components in a production vehicle and represents a milestone in the application of natural fibres. Exterior components pose interesting issues for the manufacturers, as in these applications the components must function as a protective cover for the vehicle and as a result the component must be able to resist a more aggressive environment (as compared to the interior applications) being exposed to both weathering effects and also chipping caused by debris making contact with the external surface.

Daimler-Chrysler made considerable investment in Research and Development in flax reinforced polyester composite for exterior or semi-exterior applications in recent years. A truck with flax-based, rather than glass-based, exterior skirting panels is now in production. Tests carried out by the Daimler-Chrysler Research Centre in Ulm, Germany, showed that these composite components stood up to impact without shattering into splinters, which is an important consideration in crash behaviour tests. They were also dimensionally stable and weather-resistant. Daimler-Chrysler suppliers found that switching from using glass fibres to natural fibres resulted in no problems in terms of the production equipment⁹ being able to use the same tools and machines and importantly at no additional cost to the manufacturer.

Daimler-Chrysler committed to producing a spare wheel well cover for the A-class vehicle in January 2002, this came into being in January 2005. The cover incorporates Abaca fibres in the exterior application of an under floor cover. It won the JEC award for innovation in May 2005 and also the Daimler Chrysler Environmental leadership award in November of the same year. The goals of the project were to create a functional safeguard component with equal characteristics to those of glass fibre products. The component also had to meet stringent test procedures which included – water crossing, kerbstone contact, shaking routes, heat, rock slides, and acoustic tests.²⁴

The benefits realised in the Travego coach include a weight reduction in the engine/transmission cover of 10% and a cost reduction of 5% over traditional materials. Fibres were typically purchased in 2002 for about 0.5-0.6 Euros/kg. This compares with approximately 1.5 Euros/kg for glass fibre rovings used in standard composite reinforcements. Natural fibres also exhibit numerous other advantages which have been reported widely in the literature over synthetic fibres^{25,26}.

One of the most recent developments within the automotive industry and announced in July of 2008, has been the release of the Lotus Eco Elise, (Figure 4). Renewable

Figure 4. Lotus Eco Elise (launched July 2008) with body panel, spoiler, seats made from natural fibres. Hemp plants growing shown in the background. (with permission)



materials such as Hemp, Eco wool, and Sisal have been utilised providing natural, biodegradable engineering materials. With the use of locally farmed Hemp (from East Anglia), the carbon miles to produce the Eco Elise are therefore reduced. Sustainable hemp technical fabrics have been used as the primary constituent in the high quality 'A' class composite body panels and spoiler. The hemp fibre has also been used in the manufacture of the lightweight lotus designed seats. The hemp material is used with a polyester resin to form

a hybrid composite, however, the intention is to use a fully recyclable resin in the future. Sisal, a renewable crop, has been used for the carpets in the Eco Elise, as it is a tough, abrasion resistant material.

Another development in the automotive industry announced in 2008 at the EcolnnovAsia 2008 event in October, related to the Mazda 5 car. In this application the manufacturer is using a bioplastic (namely PLA) in the interior consoles along with Kenaf and PLA in the seat covers. The manufacturer stated that 30% of the cars interior components were made from biobased materials.

Brake pads interestingly are one of the key components in the race to develop greener transport, with 80 million sets used in the UK every year. Since the use of asbestos was phased out in the 1980s, most have been formulated using man-made aramid fibres. They also incorporate significant amounts of heavy metal compounds. Around 20,000 tonnes of dust containing these materials are discharged into the environment as the pads wear each year. Now research into eco-friendly brake pads, backed by the Sustainable Technologies Initiative, has shown how a switch to natural fibres such as hemp, which can be grown in the UK, could offer a more sustainable solution. Researchers demonstrated how renewable fibres could reduce the reliance on synthetic materials and allow heavy metal constituents to be replaced with safer alternatives. The outcome is expected to provide up-to-date solutions to the global transport industry and its friction material supply base. Commercial development is going ahead, initially for the railway industry. The main end users, EFI, are particularly interested in exploiting the use of hemp in train brakes. Customers in Norway and other parts of Europe want to remove the use of sintered metal brakes that result in heavy metals getting into the environment. Interest is also expected from operators of underground and metro lines because of health concerns over airborne brake dust particles in enclosed spaces. The natural materials could cut production costs by a significant margin. Aramid fibre costs 20-30 times more than hemp fibre and it stands out as by far the most expensive ingredient that goes to make up a brake pad.

The two most important factors now driving the use of natural fibres by the automotive industry are cost and weight, but ease of vehicle component recycling is also an ever-increasing consideration to meet the requirements of the end of life vehicle directive. When you consider that 10million cars are scrapped in Europe each year (11m in the US), and

of those 96% are processed by shredder facilities, leaving 25% of the vehicles weight remaining as waste products in the form of plastics, fibres, foams, glass and rubber. The directive aims to 'depollute' all scrapped vehicles, avoid hazardous waste and reduce the amount of materials going to landfill sites to a maximum of 5% per car by 2015.

Figure 5. Eco-1 racing car



Racing Cars

The ethos for the Eco-1 racing car (Figure 5) was simple: 'Create a high-performance racing car that had a conscience'. Wherever possible, sustainable materials and manufacturing processes were used during construction. Eco-1 has tyres, bodywork, brake pads, lubricants and fuel made from natural, renewable materials. The chassis is made from steel and aluminium which can be recycled easily and efficiently. The tyres have a component which is

made from Potato or maize starch and are commercially available road legal tyres that offer very low rolling resistance. The hydraulic oil and the engine oil are a plant oil ester (which can also be used in a standard road car). The brake pads are made from CNSL (Cashew Nut Shell Liquid), Hemp and Jute, and the fuel to power the vehicle is derived from wheat. In total the racing car is 90-95% recyclable or biodegradable. Just because the materials the car is made from are friendly to the environment, it doesn't mean that performance has to be compromised. It is a car with a power-to-weight ratio of 350bhp per tonne, a car that does 0-62mph in four seconds, and that will go on to a top speed in excess of 125mph.

CONSTRUCTION INDUSTRY

The construction industry constitutes the second largest sector to employ natural materials in a range of products which include (but are not limited to):

1. Light structural walls
2. Insulation materials
3. Floor and wall coverings
4. Geotextiles
5. Thatch Roofing

We are also seeing a range of products such as sisal cement products – roof tiles and building blocks being produced in countries such as Tanzania and Brazil. Coir based products from India, which are strong, naturally termite and insect resistant, waterproof, flame resistant and carpenter friendly (excellent nail and screw holding properties) which make them ideal candidate materials in the construction sector.

LEISURE INDUSTRY

A range of products for the leisure industry have been publicised recently incorporating natural fibres. This section identifies just a few of these products.

Fishing Rods

Cellucomp have developed a fishing rod based on carrot fibres. The material is trademarked as CURRAN and is made from a high strength biofibre. The fibre used is nanoscopic in size which not only provides incredible strength, stiffness and toughness but also allows for a very smooth surface finish in the final product. The fibres have a stiffness of 130GPa, strength of upto 5GPa and failure strains of over 5%. The CURRAN material can also be utilised in a range of other sports equipment such as snowboards. The new "Just Cast" rods are around 50 per cent carrot - each made with around 2kg of the vegetables. But it is hoped that as the technique is developed, they will eventually be able to make products which are made from 100 per cent biological matter - carrots and other plants. Through a special process, nano fibres found in carrots are extracted and combined with high-tech resins enabling tough, durable components to be moulded to whatever shape, degree of stiffness, strength or lightness required. The company are already looking at using other vegetables such as turnips, swede and parsnips for other applications. It is interesting to note that carrots were one of the candidate materials considered by Henry Ford back in the early 1930's for use in vehicle body parts.

Audio Components

Eureka project E! 2819- Factory Ecoplast is combining natural fibres with thermoplastics to create new recyclable compounds for consumer products and audio components. Partners in the Eureka Factory Ecoplast project decided to join efforts to develop a palletised compound suitable for injection moulding and extrusion processes, combining two or more

material components in such a way that the resulting compound is better than any of the individual components alone. The new materials are suitable for use in the manufacture of a wide variety of products, including vacuum cleaner and lawn mower parts, storage boxes and even golf tees. Further tests of the project's new 'Eureka' speaker boxes show higher frequency acoustic performance on a par with market leaders.

Bicycles

The Museeuw bicycle incorporates flax fibres along with carbon fibres to produce the 'flax carbon hybrid race bike'. This bicycle was designed and built by the former world cycling champion Johan Museeuw. The bikes (3 different designs) are manufactured by hand and provide a unique combination of exceptional stiffness and tremendous absorption, providing a very pleasing ride (according to users) without any additional weight. Future developments include creating a wheel from 50% flax and 50% carbon fibre.

MISCELLANEOUS PRODUCTS

Included in this category are items such as grinding wheel discs with 1million units being produced each year under the trade name Plantex, in this instance hemp and polypropylene (PP) are being used to create the backing plates for these industrial products.

Cosmetic packaging is an area also seeing the adoption of natural fibres. In the USA, a lip stick casing made from Flax fibres and PP which has been on sale for 4 years selling 4million units per year.

Funeral Urns made from natural fibres and PLA which after a limited time wil naturally decompose leaving no physical residue behind.

Key events such as the 2008 Olympics hosted by China and held in Beijing (predominantly) presented an ideal opportunity to utilise natural materials on a global stage. This event alone used 80,000 tonnes of natural fibres, mainly in the buildings.

CONCLUSIONS

The use of natural fibres in a range of industrial applications has increased significantly over the last decade. The possibilities of utilising natural fibres are now being realised and as a result there are now numerous examples where natural materials have found application in a number of diverse sectors from automotive and construction industries, to packaging and leisure based products.

The recent surge of activity has been driven by an increase in western governments seeking polymer materials which are not reliant on crude oil; seeking lighter weight materials which can reduce carbon emissions by reducing vehicle weight; seeking natural insulation materials to improve energy efficiency of buildings; seeking carbon sinks such as forests (and forest products – timber) to lock up carbon dioxide; seeking recyclable or compostable materials which can reduce the landfill crisis.

An increase in consumer awareness on the subject of recycling and the impact that materials have on the environment have also played a key role in the adoption of these novel materials. A greater understanding of natural composite materials by researchers are also contributing to a greater interest and uptake in these natural based composite systems by industry that will continue to lead to more and more products entering the marketplace in the future.

References

- ¹ B. C. Suddell and W. J. Evans, Natural Fiber Composites in Automotive Applications in Natural Fibres in Biopolymers & Their BioComposites., Editors A. K. Mohanty, M. Misra and L. T. Drzal, CRC Press (2005) pp. 231-259
- ² J. Motovalli, "Better Ideas – Environmentally safe car", The Environmental Magazine, May 1999
- ³ B. C. Suddell, The Current Situation and Future Outlook for Natural Fibres within the Automotive Industry, Food and Agriculture Organisation (FAO) of the United Nations, Joint meeting of the 32nd session of the Intergovernmental group on hard fibres and the 34th session of the intergovernmental group on Jute, Kenaf and Allied Fibres, 8-11 July 2003, Salvador, Brazil
- ⁴ K. Joseph, L.H.C. Mattoso, R.D. Toledo, S. Thomas, L.H. De Carvalho, L. Pothen, S. Kala and B. James, "Natural fibre reinforced thermoplastic composites", Proceedings, Natural Polymers and Agrofibrines Composites, E. Frollini, A.L. Leao and L.H.C. Mattoso Eds., Sao Carlos, Brazil, 2000, pp.159-201
- ⁵ M. Hughes, "Sustainable composites – fact or fiction?", Oral Presentation, Composites Processing 2002, Composites Processing Association, Holiday Inn, Birmingham airport, 24th January 2002
- ⁶ L.M. Lewin and E.M. Pearce, Handbook of Fibre Science and Technology, Vol IV, Fibre Chemistry, Marcel Decker Pub., New York, 1985
- ⁷ M.R. Piggot, Load Bearing Fibre Composites, Pergamon Press, Oxford, 1980
- ⁸ A. K. Bledzki, V.E. Sperber and O. Faruk, Natural and Wood Fibre Reinforcement in Polymers, Rapra Review Reports No. 152, 2002
- ⁹ Daimler Chrysler Environmental Report Magazine 2001, pp.53
- ¹⁰ S. Hill, Cars that grow on trees, New Scientist, February 1997, pp.36-39
- ¹¹ C. Bernal, H. Cabral and A. Vazquez, Proceedings, 10th European Conference on Composite Materials (ECCM-10), June 3-7, 2002, Brugge, Belgium
- ¹² D.N. Saheb and J.P. Jog, Advances in Polymer Technology, Vol18. pp.351-363, 1999
- ¹³ I. Van de Weyenberg and I. Verpoest, Proceedings, 10th European Conference on Composite Materials (ECCM-10), June 3-7, 2002, Brugge, Belgium
- ¹⁴ P. Wambua, J. Ivens and I Verpoest, Composites Science and Technology 63 (2003) pp. 1259-1264
- ¹⁵ S. Thomas, Proceedings, 10th European Conference on Composite Materials (ECCM-10), June 3-7, 2002, Brugge, Belgium
- ¹⁶ Racz, 2005
- ¹⁷ B. C. Suddell, and W.J. Evans, Plenary Address at 7th International conference on woodfibre-plastic Composites (and other natural Fibres), 19-20th May 2003, Monona Terrace Community and Convention centre, Madison, Wisconsin, USA
- ¹⁸ G.C. Ellison and R. McNaught, UK government MAFF report reference NF0309, February 2000
- ¹⁹ M. Karus, M. Kaup and D. Lohmeyer, Nova Institute report Project number 99NR163, March 2000
- ²⁰ B. C. Suddell, Keynote Speech, Natural Composites – The Solution?, Composites Innovation – Improved Sustainability and Environmental Performance, 4-5th October 2007, Barcelona Spain
- ²¹ B.C.Suddell, Keynote Presentation, Innovative Natural Composite Materials, Natural Materials event, 7th March 2008, Institute of Materials, Minerals and Mining, London
- ²² A. Taylor, 4th Meeting of Government-Industry Forum on Non-Food Uses of Crops, GIFNFC 4/4 Fibres in Composite Materials, 22nd January 2002, DTI Conference Centre, London
- ²³ The Vancouver Province, 'Volvo experimenting with natural fibres for car components', 14th October 2005
- ²⁴ T. Nishimura, Presentation given at SusCompNet 7 meeting, University of Bath, UK., October 11th 2004
- ²⁵ D. Ruys, A. Crosky and W. J. Evans, Int. J. of Materials & Product Technology, Vol. 17, Nos 1 / 2, 2002, pp. 2-10
- ²⁶ M. Flake, A. Hansen, G. Fischhaber and S. Schaper, Proceedings, Natural Fibres for the Automotive Industry, IJIMIST Manchester 28 November 2000

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Overview

Wool production continues to be one of Australia's most important agricultural industries, representing 6.3% of the gross value of agricultural production and \$2.3 billion in export income in 2003-2004.

The current sheep flock of 107 million occupies some 25% of Australia's land mass, with approximately 30% of the flock in the high rainfall zone, 55% in the sheep/cereal zone and 15% in the pastoral zone.

The natural resource base of soil, water and vegetation provide the fundamentals on which the wool industry builds significant economic and social benefits for the nation. In addition, the effective control of pests and weeds increases productivity, reduces production costs and delivers benefits to the natural ecosystems. This all greatly assists wool growers demonstrate their sense of pride in their farms and their desire to see their assets passed on to future generations in better condition.

Merino wool - the perfect choice for today's fast paced environment

Faced with an abundance of choice, consumers will always look for quality. Merino wool is the smart, timeless and versatile fibre choice, with the added advantage of being produced in a natural, sustainable manner.

Time is the most precious commodity for today's consumers, and thanks to evolution and innovation, Merino wool has easy care, quick dry qualities, making them practical and convenient for time-poor consumers. The transeasonal attributes of Merino wool also make it the perfect apparel choice for busy professionals - providing protection from the cold in the harsh outdoor weather whilst providing comfort in air conditioned environments such as offices, public transport and planes.



Recognised by many as the most luxurious natural fibre in the world, Australian Merino wool offers all the qualities that today's consumers need and expect from their garments.

THE AUSTRALIAN WOOL INDUSTRY AT A GLANCE

- 30,000 farms
- 1,000 to 40,000 sheep
- 10 bales to 1,500 bales
- Fibre diameter: 11 micron to 40 micron
- Fibre Length: 55mm to 130mm
- Fibre strength: 10 to 65 N/Ktex
- 20,000 different types of wool
- 22,000 registered Woolclassers



The Australian wool industry and the fibre is very diverse owing to it being a product of its natural environment. The grazing industries have a unique opportunity to demonstrate that rural landscapes can be managed to effectively support profitable grazing enterprises, the natural environment and rural communities, while meeting the needs of increasingly environmentally aware consumers.



From 2002 to 2006 AWI's major investment in natural resource management was Land Water & Wool, www.landwaterwool.gov.au. While the Land Water & Wool research component drew to conclusion in 2006, AWI will continue to promote the knowledge and tools developed to woolgrowers and industry via other AWI investments. Other AWI natural resource management investments are drought, rabbits and the development of an environmental assurance system for broadacre producers.

AUSTRALIA: A UNIQUE ENVIRONMENT FOR WOOL GROWING

Did you know...Some fast facts about the Australian wool industry

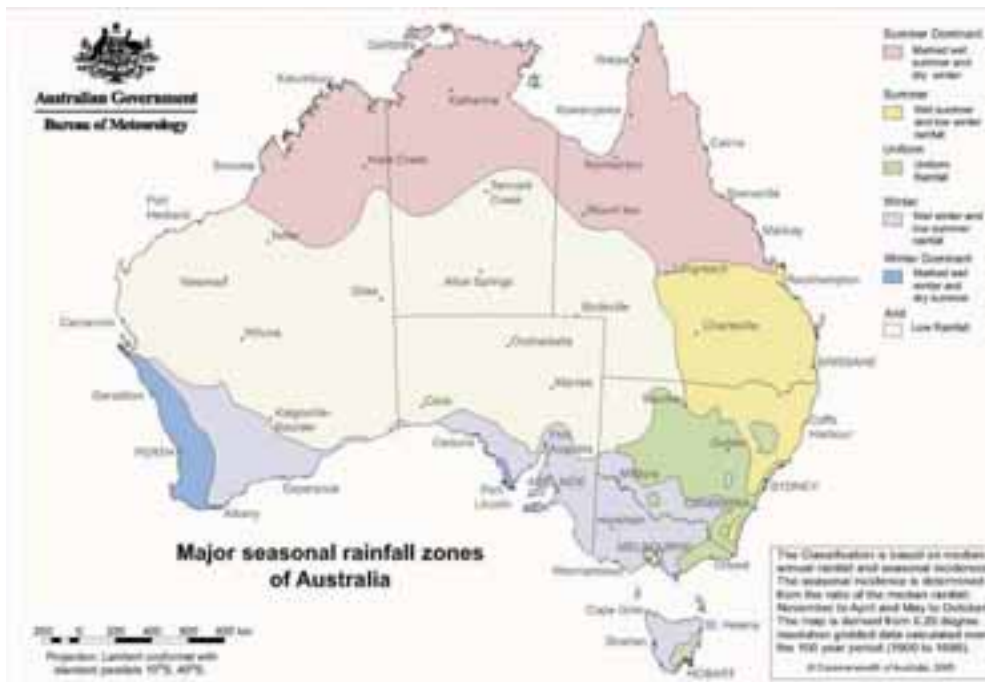
Australia is the world's largest producer of wool.

In 2005/2006 there were 107 million sheep shorn in Australia producing 461 million kg of greasy wool.

Production for 2006/2007 is forecasted to be 425 million kg of greasy wool with production still impacted by the drought.

The Australian flock of 100 million sheep is composed of 88% Merino, 9% crossbred and 3% other breeds as at 1 January 2007.

Sheep graze over 85 m ha of Australia's total land mass. This means on average each sheep has 0.85 ha or 2 acres.



Australian wool production 2005/2006 461 million kg greasy

Australian Wool Exports

Did you know...

Australia is the world’s largest producer of wool, producing 27% of the world’s greasy wool in 2005/2006.

While Australia produces more wool than any other country, China has the largest sheep population.

Wool exports were valued at \$2.64 billion in 2005/2006.

Wool Textiles

Did you know...

In 2008, wool accounted for 1.9% of total world fibre use.

Australian wool is primarily utilised in production of knitwear (27% of our clip), and men’s and women’s wovens (60%).

Young adults, who dominate global discretionary apparel expenditure, are influenced more by price and performance rather than the textile fibre used.

Worsted fabrics are made with longer fibres that produce a surface that’s smooth to touch. Woollens are made with shorter fibres that stand up from the surface and give the fabric a hairy touch.

Wool is natural, biodegradable, naturally flame resistant and able to absorb up to one-third of its own weight in water.

Who is Australian Wool Innovation?

Australian Wool Innovation (AWI) is the world's leading Merino wool fibre marketing and innovation company.

AWI is a not-for-profit organisation investing close to \$60 million each year in marketing & research.

Our goal is to build demand for Australian Merino wool and the profitability of our shareholders: Australian wool growers

Australian Wool Innovation (AWI) is the world's leading Merino wool fibre marketing and innovation company. AWI is a not-for-profit organisation investing close to \$60 million each year in research. We are funded by Australian wool growers. Australian sheep growers contribute around 80% and Australian Government 20%

Our goal is to build demand for Australian Merino wool and the profitability of our shareholders: Australian wool growers

How do we do this?

1. Development, marketing and innovation right through the apparel pipeline – from farm to fibre to fashion.
2. AWI develops business-to-business relationships with global apparel decision makers, leading product developers, designers, manufacturers and retailers.
 - 60% of investment is directed at marketing and post-farm gate R&D, and 40% is directed on-farm
 - AWI has a long history of investment in environmental assurance and ethical production.
 - For example, from 2001 to 2006, AWI invested \$20m in the Land Water Wool Program, as part of a \$60 m joint venture

Fine and superfine Merinos

Fine and superfine Merinos are found in the northern and southern tablelands of New South Wales, the western districts of Victoria and the midlands district of Tasmania.

The super-fine wool Merino produces wool that is of excellent colour, soft handling and dense, with a fibre diameter of 18 microns. Staple length is about 70mm.



The fine-wool Merino possesses a bright, white, dense fleece. Fibre diameter is 19 microns with a staple length of about 75mm.

Medium-wool Merinos

Medium-wool Merinos are found throughout New South Wales, Queensland, Victoria and Western Australia. They are grown primarily for wool production. Their wool is almost totally absorbed by the textile trade. Their fleece is heavy and soft handling, of good colour with a fibre diameter of 20-22 microns and a staple length of approximately 90mm.

Strong-wool Merinos

Strong-wool Merinos are most prominent in western New South Wales, South Australia and Western Australia. The strong-wool Merino produces a heavy seven-to-eight kilogram fleece of approximately 100mm staple length with a fibre diameter of 23-25 microns.

The Fonthill Merino

The Fonthill Merino was evolved by crossing American-bred Rambouillet Merino rams with a fine-wool Saxon strain of Merino. The major objective was to increase the genetic potential of an easy-care type sheep to produce wool. Fonthill ewes produce 20-22 micron wool.

The Booroola Merino

The Booroola Merino was originally developed on the Southern Tablelands of New South Wales and is the subject of a continuing developmental programme initiated by Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO).

AWI work from on farm right the way through to the retail shelf: Just one example is with New wool harvesting technologies



AWI is continually researching alternative harvesting technology in order to improve workplace safety and boost the quality of the wool gathered. These developments include shearing platforms such as the Peak Hill ShearEzy UPSP and biological harvesting.

Australian Wool In-novation Limited (AWI) is developing new 'add-on' shearing technologies to make current and future wool harvesting equipment safer and more effective.

This is a core part of the company's strategy to cut sheep shearing costs and improve efficiencies in the wool harvesting sector.

Add-on technologies being investigated include:

- safer conventional shearing handpieces;
- new handpiece technologies; and
- new shearing shed designs based on best practice occupational health and safety (OH&S)
- better methods of restraining sheep on shearing and crutching trailers.
- Improvements to handpieces, better shearing shed designs and implementation of

other shearing technologies should benefit woolgrowers, shearers and wool handlers by:

- improving wool harvesting efficiency;
- cutting the costs of shearing;
- improving clip preparation quality and value; and
- making shearing and wool handling safer and more attractive professions.

Developing markets

The fundamental premise of AWI is to drive research, development and innovation that will increase profitability for Australian woolgrowers. At an industry level this is done by the development of business in new and existing markets.



Our strategy

One of AWI's primary business objectives is to foster the creation of new markets for Australian woolgrowers. These markets are developed by building close business partnerships in new and existing markets.

New Markets

The rapid economic development and growth of manufacturing in countries such as India, Russia and, particularly, China are offering many new opportunities for Australian wool.

Building existing markets

Traditional markets are fundamental to the direction of the industry and are home to many powerful companies and influential designers. AWI works very closely in collaboration with business partners to create products that open new possibilities within these markets.

China

As a global centre for production and as Australia's most significant export destination for wool, issues affecting trade with China are vital.

Overview

At the end of the wool pipeline, AWI is creating huge new opportunities for Australian woolgrowers amongst international markets.

The works being undertaken with our business partners in both new and established markets, particularly in China, have the potential to deliver very significant returns.

The establishment of AWI offices in key new markets is fundamental to ensuring that we understand these regions, their consumers and are as close to our business partners as possible.

Product development

Fundamental to the ongoing success of Australian Merino is the creation of innovative apparel products and technologies that are sought-after by the world’s apparel markets and consumers.

AWI and its business partners actively seek out what retailers want to sell and their customers want to buy and then engage people to produce fabrics to meet these needs directly.



Our Strategy

AWI manages highly focussed research and development programs to create unique and innovative products. These products are sold into or developed collaboratively with our global business partners.

Textile innovation

Maintaining the best prices and highest demand for Australian Merino requires that AWI is constantly bringing innovative products to market, products that exemplify wool’s advantages, and add new characteristics that consumers want. Merino Care, Merino Soft and Merino Visual are examples of product innovation from the knitwear segment.

Overview

The Australian Merino product that AWI develops and that manufacturers and retailers deliver to consumers is the fundamental working of the wool pipeline.

Driven by innovation, but always targeted to addressing a specific challenge or consumer desire, AWI undertakes product development to always expand the markets for Australian wool.



Of particular importance are the relationships that AWI shares with many significant business partners with whom the creation of remarkable, innovative wool products is undertaken.

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Merino Care

The Merino Care range has been created to ensure Merino wool garments are as easy to maintain.

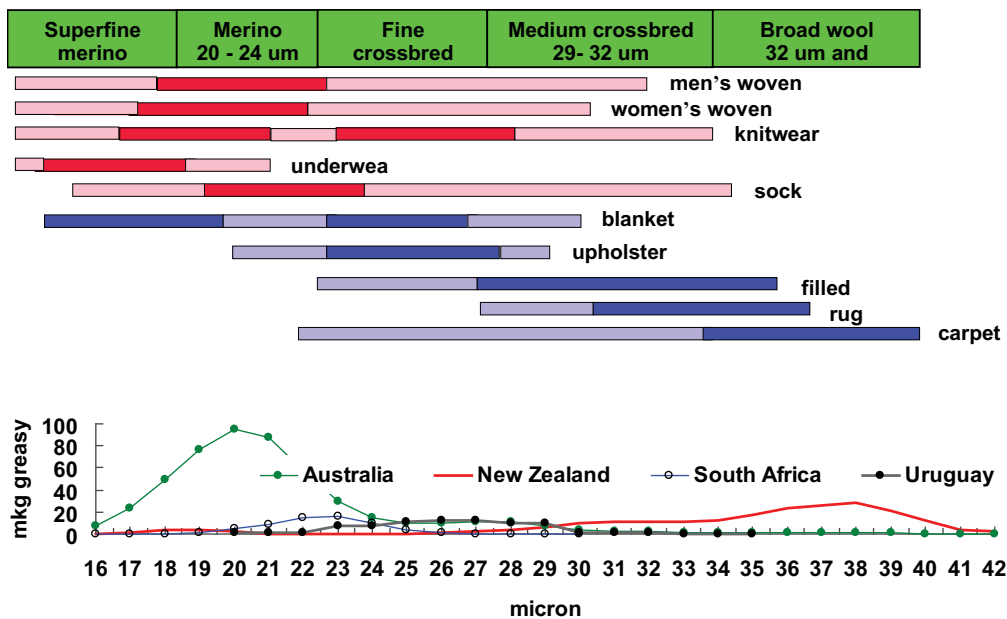
Merino Soft

The Merino Soft range utilises unique production and treatment methods to deliver the softest, most luxurious Merino garments.

Merino Visual

AWI developed a number of techniques that make garments much more appealing to the eye for consumers.

WOOL USAGE AND FIBRE DIAMETER



Global fibre market

- Merino wool destined for world clothing markets (<16-24 micron) dominates the Australian wool supply.
- This reflects both the adaptability of Merino sheep to Australia's many production environments and the higher value of finer Merino wool.
- In 2000-2001 a total of 3,630,000 bales were tested: 87 per cent were 24 microns or finer (apparel), 18 per cent were 19 microns or finer, and 13 per cent were broader than 24 microns.
- During the 1990s, supply of wools from Australia - the largest wool producer - and from most other regions fell, with the exceptions of China and New Zealand.

- Wool's share of global fibre usage has declined significantly.
- The world market for fibres has tripled in 40 years, but synthetics have accounted for most of the growth.
- Wool use has been regular in quantity but small in market share; from near 10 per cent of fibre use around 1960 falling to 2.5 per cent in 2000 (or about five per cent of apparel fibre).

Australian Wool Fibre

There has been a significant change in the fibre diameter (micron) profile of the Australian clip. In 1993/1994 only 8.5% of the total clip was 19 micron or finer.

Twelve years later (2005/2006), 31% was 19 micron or finer. In 2006/2007 it is predicted this proportion will reach 36%.

Wool fibres are mostly made of protein with a small amount of fat, calcium and sodium.

As it grows from the sheep's skin, wool naturally groups into staples which each contain many thousands of fibres.

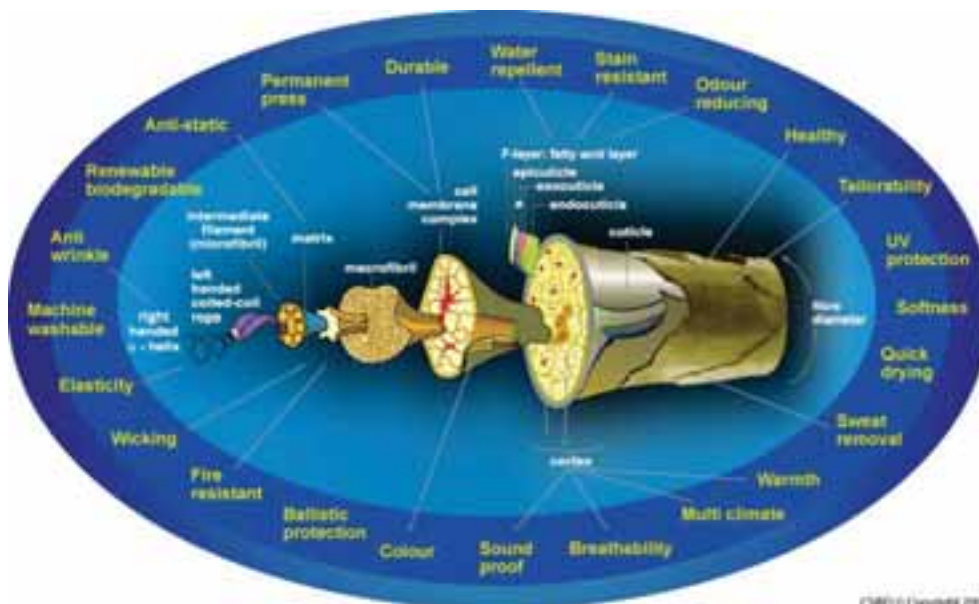
After shearing, wool is classed into five main categories: fleece, pieces, bellies, crutchings and locks.

The most important characteristics of wool in determining its greasy value are fibre diameter, staple strength, staple length, vegetable matter, colour and yield.

MILLIONS OF YEARS OF EVOLUTION MAKE MERINO THE PERFORMANCE FIBRE

Proof of the attributes of Australian Merino

The Australian Merino fibre has a remarkable range of natural attributes. In this section, through being introduced to some of its physical and chemical properties, you'll find out why.



The fineness of the Merino fibre makes it soft, and provides great insulation, how its scales make it water repellent and help resist stains, how its ability to absorb moisture aids breathability and contributes to odour resistance, how its elasticity delivers excellent drape and eliminates wrinkles, and more.

WOOL HAS INTRINSIC PROPERTIES THAT TRANSLATE TO GARMENT FUNCTIONALITIES THAT MAKE IT IDEAL FOR APPAREL USE.

- Natural Breathability
- Natural durability
- Natural stretch and drape
- Natural odour resistance
- Natural temperature control
- Natural fire and static resistance
- Natural UV protection
- Natural sweat and moisture control



Water Repellent

While the core of the Merino fibre is hydrophilic and capable of absorbing up to a third of its dry weight in moisture vapour, the surface of Merino is hydrophobic. That is, it repels liquids.

Waxy coating

The Merino fibre has a very thin, waxy, lipid coating chemically bonded to the surface. This bonded layer extends over the overlapping scales on the surface of the fibres and cannot be easily removed by scouring, washing or processing. A consequence of this surface layer is that Merino fibres have a naturally low surface energy - lower than cotton, nylon or polyester and comparable with the hydrophobic surface of polypropylene. (Fig 1)

It's this low surface energy that makes Merino water-repellent because droplets that touch lightly on the surface of Merino will bead and roll off before being absorbed into the fabric.

Summary

A waxy lipid coating on the scales of the Merino fibre lower its surface energy and make it naturally water repellent.

Further reading:

CSIRO, "Stain resist, anti-soiling and easy clean", 2005.
 Holme, I., (2003) Water-repellency and water proofing, in Heywood, D. (Ed.)
 Textile Finishing, Bradford, UK: Society of Dyers and Colourists, pp. 135-213.

WOOL: NATURALLY ABSORBS WATER VAPOUR AND IS BREATHABLE

SOURCE: CSIRO

- Wool is an active fibre.
- It is able to absorb and desorb moisture vapour as conditions around it change.
- This gives wool its fantastic 'comfort' properties and makes it 'breathable'.

Breathability

When someone says a garment "breathes" they are referring to its ability to dissipate perspiration so that they don't feel "clammy". The scientific term for "breathability" is moisture buffering.

Moisture buffering

Moisture buffering refers to a textile's capacity to absorb moisture vapour from the micro-climate above the skin when there is a rise in humidity and release it again if the humidity should drop. A textile's propensity to absorb moisture vapour is known as its hygroscopicity, while the weight of water able to be absorbed by a fibre as a percentage of its dry weight is known as the regain.



Merino has highest regain

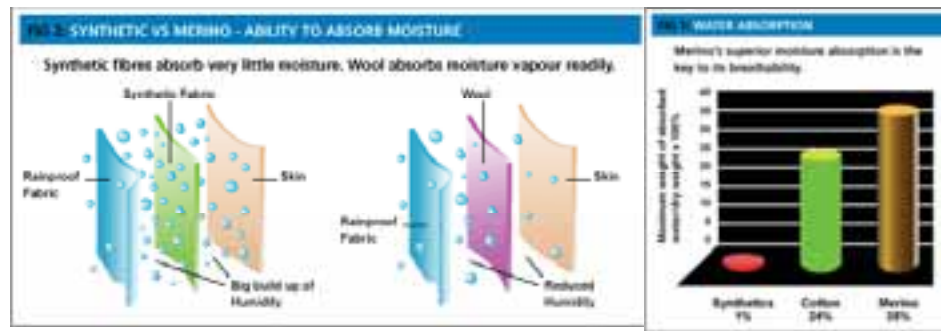
For synthetics the regain can be as low as 1%, for cotton it's 24%, while Merino has the highest regain with an ability to absorb 35% of its own dry weight in water. (Fig 1)

Merino has the greatest capacity to absorb moisture vapour of all apparel fibres because its internal structure is more complex than synthetic fibres, creating more sites where moisture can bind. This higher regain means that Merino is better able to absorb the moisture vapour produced by the wearer and so lower the humidity in the micro-climate between the skin and the garment.

MERINO PERFORMANCE FACTS

Moisture transport

Further enhancing Merino's perception of breathability is its superior moisture transport. When a person is sweating the air near the skin is humid while that further away is drier. Just as different textiles have varying abilities to absorb moisture vapour as they move towards sweating skin, so do they vary in their capacity to release it again when they move away into the drier air.



Merino's superior moisture transport

Tests conducted by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in Australia showed that Merino was twice as effective at absorbing and releasing sweat as an equivalent polyester fabric. It is this ability to not just absorb more moisture vapour but also release it that explains why Merino is so effective at reducing the uncomfortable sensation of clamminess.

Temperature drop with vaporisation

There is a further factor that enhances the qualitative assessment that Merino feels more "breathable". When a textile absorbs liquid sweat within its internal structure and it evaporates at the surface there is an accompanying drop in temperature. For most textiles, this effect is negligible because of their limited capacity to absorb moisture. But, because Merino can absorb so much liquid, the temperature drop is noticeable.

Heat of sorption

Conversely, if the ambient temperature should drop, moisture from the air can be absorbed by Merino and converted to bound liquid, a process that produces a rise in temperature known as the "heat of sorption".

Thermo-neutral

This ability of Merino to respond to changes in the microclimate above the skin, producing a drop in temperature when you sweat, and a rise in temperature when you chill enhances the qualitative sensation to the wearer that Australian Merino has excellent "breathability".

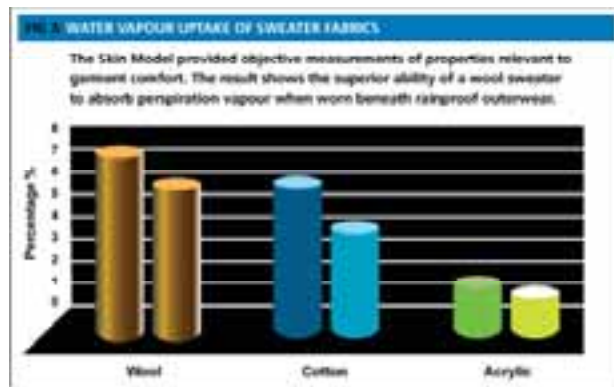
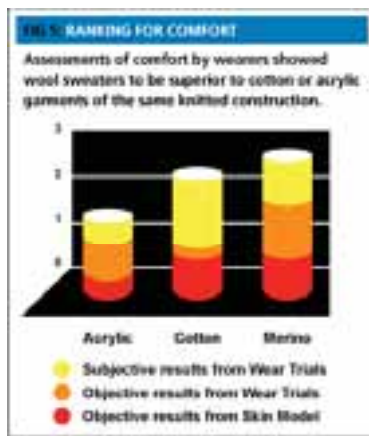
Laboratory proof of Merino's breathability

A number of tests have been done which support the anecdotal evidence concerning Merino's "breathability".

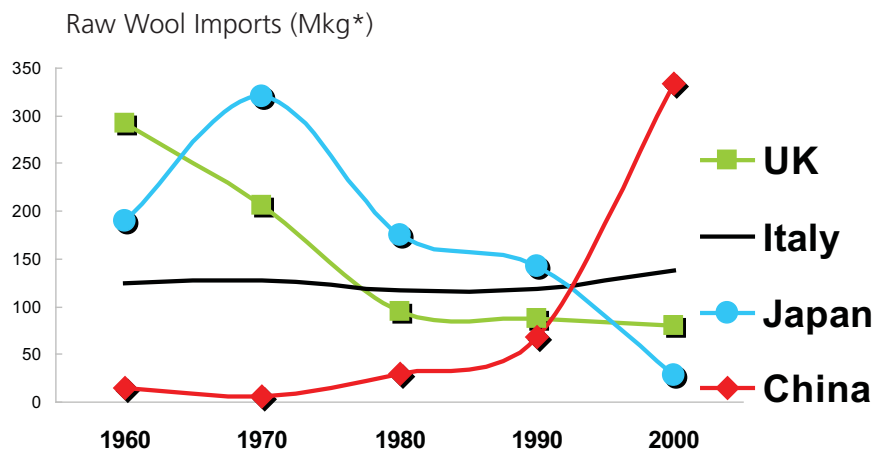
The Hohenstein Institute in Germany performed trials to investigate wearer comfort when sweaters made from different textiles were worn under rainproof outerwear, a common combination for sport and outdoor enthusiasts.

Merino superior to cotton and acrylics

The Hohenstein tests confirmed that a Merino sweater absorbed more moisture vapour than cotton or acrylic equivalents and, in wearer trials, both objective and subjective assessments rated Merino as providing superior comfort to either cotton or synthetics



THERE HAS BEEN A HUGE GEOGRAPHIC SHIFT IN GLOBAL WOOL PROCESSING



The wool marketplace

Twenty years ago, most Australian wool was transported to Japan, the USSR and Western Europe. Today, China and Italy are the major destinations for Australian greasy or part-processed wool. A substantial part of Japanese wool processing capacity has been relocated to lower cost China, reflecting again the price pressures on textile manufacture.

World trade in fabric and finished products has expanded rapidly as retailers source goods from manufacturers worldwide. Alongside reductions in overall wool, trade in yarn, fabric and apparel items has grown 12 per cent. This is expected to escalate as trade barriers are reduced.

Early stage processing in Australia has expanded in the last decade also in response to economic, marketplace and environmental realities. Over 30 per cent of wool is scoured and much made into tops before being exported.

However, spinning, weaving, knitting and fabric production declined even though Australian import tariffs are continuing until 2005. The year 2000 saw an eight per cent increase in local yarn making offset by a 13 per cent fall in fabric making and higher imports of yarns and fabrics.

Wool, as a naturally grown and complex product, is expensive compared to alternatives at all stages - from raw material purchase through to spinning where the additional cost is particularly high.

AWI invests in research, development and innovation that aims to reduce costs and improve production efficiencies at all stages along the wool pipeline.

That wool continues to sell in the face of such comparative costs is testimony to [wool's intrinsic qualities](#).

There are two distinct methods of wool yarn production:

1. The Worsted System

- Uses longer length wools (greater than 65mm staple length).
- Wool is made into tops before spinning into yarn.
- Eighty per cent of Australia's wool is processed this way.

2. The Woollen System

- Uses much shorter wool such as locks, crutchings, bellies and lambs wool.
- All carbonised wool and a substantial amount of scoured wool is processed this way.
- Produces a bulkier yarn that is used in knitting and some weaving.

The six major processes of worsted yarn are:



Scouring - a washing process that removes dust, suint (sweat) and wool wax.

Carding - rollers covered with teeth tease apart the staples of wool, laying the fibres nearly parallel to form a soft rope called a 'sliver'.

Combing - the comb separates short from long fibres, ensuring

that the long fibres are laid parallel to produce a combed sliver called a 'top'.

Drawing - several tops are drawn out into the thickness of one, to thoroughly blend the wool and ensure evenness or regularity of the resulting 'roving'.

Finisher drawing - reduces the roving thickness to suit the spinning operation and further improve evenness.

Spinning - insertion of twist into the yarn to give strength to the finished yarn.



The woollen processing system can be varied to meet various market requirements. Variance in processing methods occurs either chemically or physically.

- Chemical processing variances include:
 - Shrink proofing;
 - Fire proofing; and
 - Moth proofing.
- Physical processing variances include:
 - Blending exotic fibres, such as cashmere or silk; and
 - Blending man-made fibres.

Worsted vs woollen fabrics

- Worsted fabrics are often more expensive than wool spun products due to the longer raw material to resultant yarn processing route used.
- Worsted fabric is stronger and wears better than a woollen spun fabric of equivalent weave construction and fabric weight.
- Worsted fabrics are preferred for trousers, suitings, other garments and upholstery fabrics where a smooth finish is required.
- Woollen spun fabrics are used for jackets, coats, skirts, upholstery fabrics, rugs and blankets where bulk and textured finishes are desirable.



Further results of research

The results of research in 2005-06 saw the establishment of a variety of commercial contracts that will directly deliver benefits back to Australian woolgrowers.

Each of these have been expressly developed to make wool garments easier to produce and ultimately more wearable:

- Chlorine-free continuous shrink-resistant treatment for wool loose stock and tops
- Novel self twist yarns using modified false twist spinning techniques to develop a range of knitted and woven apparel products
- Performance-plus protective clothing made from mid-micron Australian Merino fibre
- Light weight, low pilling, woollen knitwear using compact yarn
- Australian Merino range of products that cater for the leisure / travel market in conjunction with Purely Merino
- Novel knit fabric development and commercialisation of a range of novel, low cost, wool-rich fabrics based on AWI patented technology
- Performance Plus: the introduction of new finished, fibre blends and chemical applications to wool to add value and exceed the requirements of the military, corporate, institutional and industrial sectors

Environmentally assured Australian Merino wool

Today you cannot make a decision without thinking of the **repercussions for the environment**. This goes for lifestyle decisions regarding your food, car, plane ticket - even your clothing.

We are all aware of the current and growing concerns regarding climate change, the environment, carbon emissions, our own ecological footprint, and local and global impact.

- 'Green' fashion is growing in popularity throughout the western world
- Iconic brands and new companies are opting for textiles that leave a minimal ecological footprint

But where does Australian Merino wool fit in this story?

The swing towards eco-friendly products brings opportunities for the global textile industry, and for their part, Australian woolgrowers. After years of rampant consumerism, active and informed consumers are insisting on greater integrity and authenticity in the products they buy.



Research conducted by AWI strongly supports the importance of this emergent sector. A sentiment survey of **22,000 consumers in 11 key markets** indicates a significant consumer market segment with a preference for natural, organic products.

UK retail giant Marks & Spencer recently announced a five-year, £200 million eco-plan that forecasts that organic wool and cotton apparel sales will triple.

AUSTRALIAN MERINO WOOL GROWERS

- Care for and enhance the environment upon which they earn their living: "the environment is their lifeblood"
- Improvements in Australia's farm practices are aimed at rehabilitating land; halting and reversing the loss of native vegetation; improving water quality; and enhancing biodiversity

"What about organic Australian Merino?"

We are often asked this question by retailers and suppliers and our reply is simple. What do you mean when you say "organic?" Because if you mean a totally natural and renewable fibre, that is grown and harvested with very little or no use of synthetic chemicals, then we have that already.

AWI does not use terms like "eco" and "organic" simply because our fibre is made naturally from the combination of sunlight, water and grass. Australian Merino wool is com-



pletely natural, biodegradable, sustainable (NBS), and authentic, making it an ethical choice for consumers.

Naturally Australian Merino: It comes with the Territory

Merino is a naturally luxurious and high performance fibre that has evolved over millions of years to create the most effective all-

weather protection against the elements known to man. Nature designed the Merino fleece to protect from the wind, rain, and in Australia's case, extremes of our fierce summer heat and sunshine, and alpine cold. No man made fibre can come close to replicating Merino's naturally occurring combination of attributes.

Natural

- Australian Merino wool has excellent 'natural' credentials
- It is a renewable, biodegradable protein
- More than 99% is produced in extensive grassland terrain
- Little or no synthetic chemicals are used in the production of Australian Merino wool
- The very small amount of chemicals used on wool are for the benefit and health of the animal

Biodegradable

- Australian Merino is extraordinarily durable, it will degrade and return to its component elements
- The natural fibre is made from protein, similar to that found in human hair
- Easily decomposes back into the earth, unlike most synthetics such as polypropylene which takes thousands of years to decompose

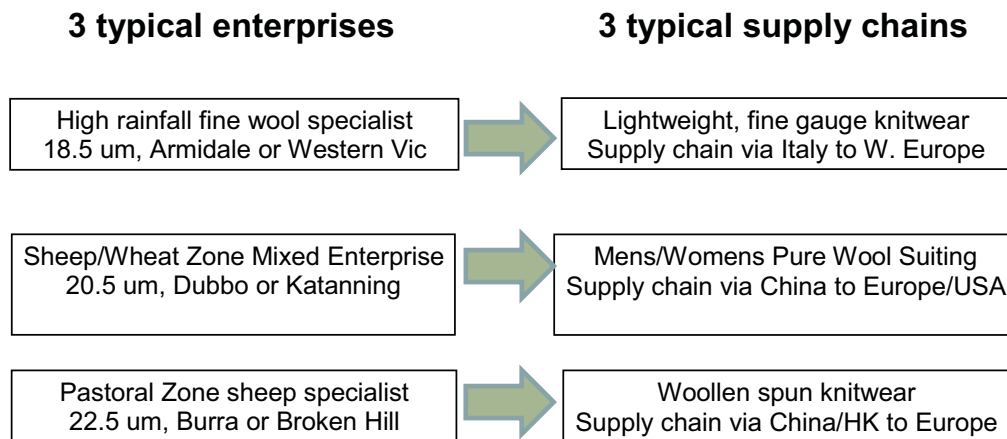
Sustainable

- Australian Merino is a sustainable resource
- Every year a new fleece grows upon the sheep's back and can be removed without harm to the animal
- Made from the simple combination of sunlight, water and grass

Verification of Australian Merino (VAM)

AWI offers a 'Verification of Australian Merino' which allows businesses to certify and promote the origin of the fibre, and therefore its natural credentials to customers.

ENVIRONMENTAL PATHWAYS AND LCAs ARE CHALLENGING: DIVERSITY IN PRODUCTION AND FINAL MARKET!



Being responsible...from fleece to fabric

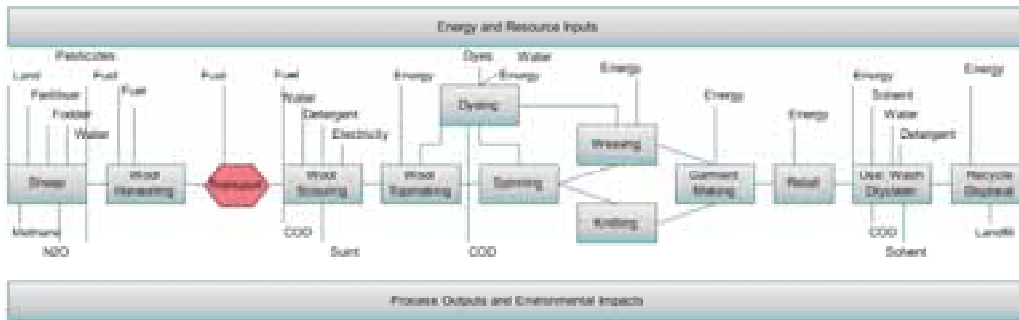
AWI has engaged the Australian Commonwealth Scientific and Industrial Research Organisation to conduct independent research on the "Environmental Pathway" - the processes required to transform wool from fleece to fabric. AWI will work in countries such as India, Bangladesh and China to look at improving the wool textile production and corporate social responsibility practices from chemical, dye and energy use to ethical labour practices.

Australian Merino wool is the premium natural fibre solution. Consumers can buy authentic, natural Australian Merino with confidence, knowing it is the eco-friendly choice. AWI are an investment company protecting and promoting wool as a natural and ecologically sound textile solution. Therefore we need to know where our greatest impacts are and to work to reduce these. Hence – we undertook a pilot Life cycle assessment. We do not look at other fibres and say they are BAD: this is not constructive

AWI initiated its LCA project in 2006, in partnership with CSIRO. The LCA scope is Defined as follows: 3 typical wool supply chains.

- Fine wool, high rainfall -> Western European use
- Medium wool, mixed enterprises -> Asian suits
- Coarse wool, pastoral zone -> outerwear knits.
- Farm to retailed garment, then back to soil (complete life cycle).
- The project adopted ISO 14040 as a template, and focussed on water and carbon dioxide emissions.

PROJECT SCOPE



The LCA study identified many gaps in our knowledge:

Carbon sequestration in soil – how much of an impact or opportunity?

Garment wear life – durable vs. rapid turnover and replacement?

Post-purchase use and disposal. We suspect most wool is recycled via Op shops, then into cardings, into geotextiles and insulation etc.

For example, Japan has run very successful clothing recycling campaigns.

Summary of our LCA experience:

- Critical to know environmental footprint, for long-term future
- Assumptions are critical – rubbish in, rubbish out
- Most water use post farm, and most CO2-e post farm. Biogenic methane remains a major issue.
- Australian impacts equivalent to that of 2% of Australia’s human population.
- We need to do more research, to address gaps in our knowledge
- We are continually looking at opportunities to reduce key elements of the footprint.

WHAT ARE THE OPPORTUNITIES TO REDUCE OUR CARBON FOOTPRINT?

Australian industry is looking at methods for reduction in on-farm emissions

Sheep CRC looking at genetics – the evidence is that there is considerable scope for reduction in per-head emissions.

The greatest challenge for Australia appears to be enteric methane, and globally, using and heating water as part of garment care.

Product innovations such as the shower suit fit with our environmental strategy.

There is scope to reduce livestock emissions:

For example, Substantial differences have been shown to exist within breeds of cattle in amount of emissions, independent of diet.



Also, Red Kangaroos don't produce methane, yet are a ruminant.

Australian industry is looking at methods for reduction in on-farm emissions. As part of a \$100 million investment by the industry and the Australian Government, researchers are looking intensively at developing required genetic and management tools for growers.

MERINOfresh™

Based on the **shower suit** technology developed with partners in Japan.

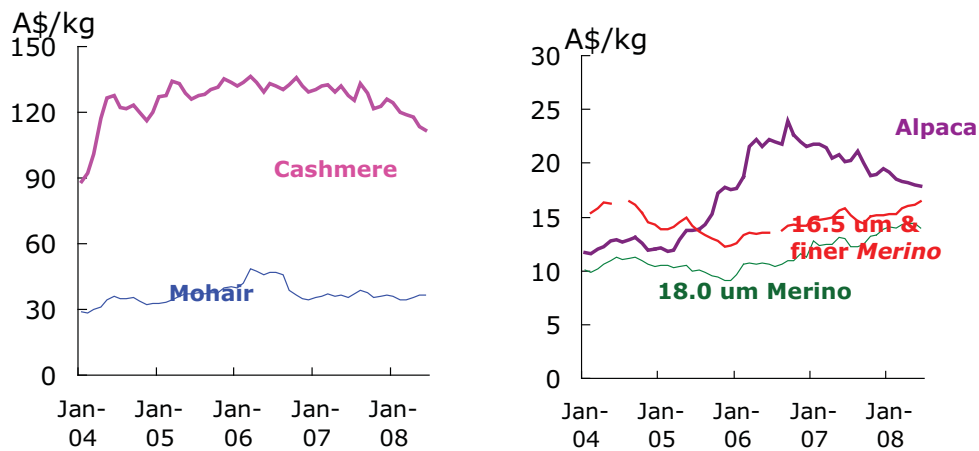
The result is an example of a better outcome in terms of performance, functionality and environment :i.e. in the LCA study after purchase care could be a big part of our 'footprint'

Very strong demand for this functionality in key Asian markets

Currently **transferring the technology** to, Sunshine (China), Raymond's (India). Strong interest from large retailers such as Hugo Boss etc.

Along with Apple's ipod, the Shower Suit was one of the best and most recognised innovations in Japan consumer surveys in 2008.

LUXURY NATURAL FIBRE PRICES: MERINO AND OTHERS MONTHLY



The Australian merino fibre is facing a number of challenges...

On the whole, fashion has moved against wool. Apparel categories where wool has traditionally had a high share have shown limited or negative growth, while the apparel categories that have exhibited the highest growth have very low wool share.

Consumer trends have also moved towards lighter garments, and this has resulted in a smaller quantity of wool used in garment production, even for 100 percent wool garments. The increasing availability of air conditioning and central heating in homes, offices, and transport has led to the increasing popularity of trans-seasonal clothing, which has a negative impact on many of the traditional uses of wool, such as heavy overcoats, heavy sweaters, blankets, and heavy men's suits.

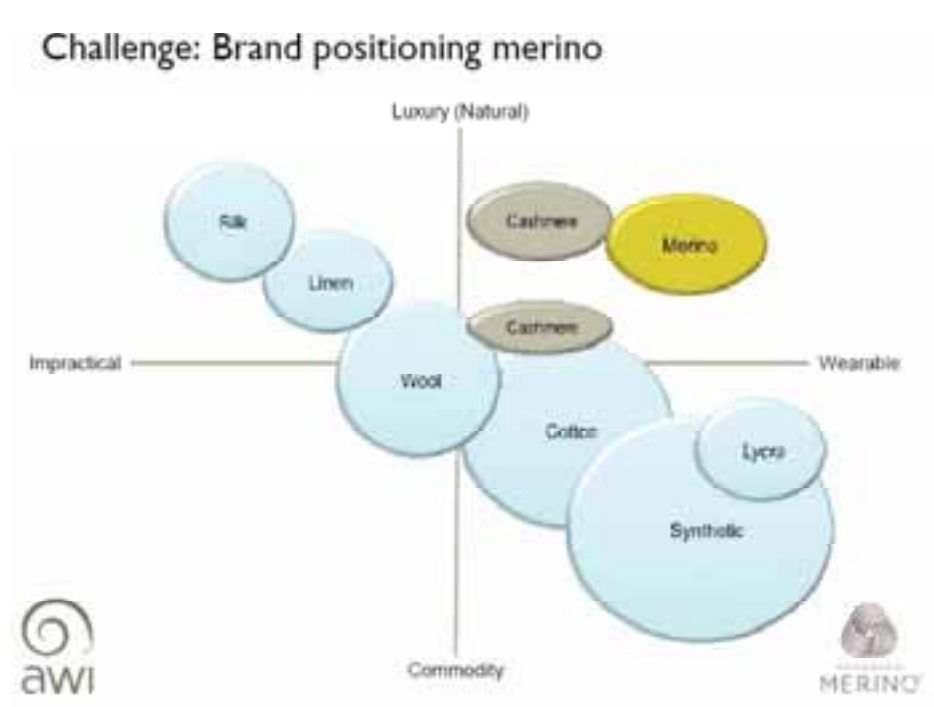
Consumers indicate that the three most important buying criteria are 'comfortable', 'available in casual styles', and 'for all seasons'. Wool currently rates poorly on all three attributes. At the other end of the spectrum the two strongest associations with wool are 'keeps you warm' and 'itchy or prickly' which, unsurprisingly, are rated extremely low as key buying attributes. On a more positive note, consumers strongly associate wool with 'natural' and 'high quality' and these are relatively important buying attributes.

The single most critical driver to improving the wool industry's profitability is to stimulate demand for wool apparel. Stimulating demand for fine and superfine wools should be the goal, given that Australian wool production has been increasingly focused on these wool types (60 percent increase over last 10 years). Australian wool farmers dominate this market with approximately 90 percent of global production of superfine wool (less than 19 micron).

CHALLENGE: BRAND POSITIONING MERINO

The market has presented us with an opportunity. There seems to be no end to the inelastic demand for luxury. But as Cashmere continues to become less consistent and cheaper at retail, Australia's Merino wool will take this high ground. Australian merino has a lot going for it:

- Natural fibre
- Renewable source of clothing



- Able to be worn next to skin
- Ultra high "natural" performance owing to millions of years of evolution
- A fibre grown to protect a mammal
- Natural moisture management
- Natural luxury
- Traceable to every farm
- Environmentally aware fibre- i.e. impacts and processing highly developed to be ecologically sound. Our environment and ecology is delicate, very dry
- Biodiversity is a key
- Animal welfare is the basis of our industry's livelihood



AWI are also the owners of the iconic Woolmark brand. A brand that has appeared on over 2 billion garments since 1964. As part of our programme to continue to promote quality and wool via this universally recognised brand AWI are reinventing the Woolmark so that it means not only a quality product but also a quality process in terms of its environmental and social attributes.

So innovation does not just happen with products but also with the supply chain from farm to fashion so to speak.

As the economy changes, as competition becomes more global, it's no longer company vs. company but supply chain vs. supply chain. — Harold Sirkin, 1994.

Great firms will fight the war for dominance in the marketplace not against individual competitors in their field but fortified by alliances with wholesalers, manufacturers, and suppliers all along the supply chain. In essence, competitive dominance will be achieved by an entire supply chain, with battles fought supply chain versus supply chain. — Roger Blackman, 1997.

Utilising our network and licensee base introducing such a standard is a way wool textiles can reduce their impact on the environment.

AWI CORPORATE SOCIAL RESPONSIBILITY CODE OF PRACTICE FOR WOOLMARK LICENCEES

- Confidence for retailers in regards how the
 - Environment
 - Chemical
 - Ethical labour
 - Traceability



One of the key components of this strategy is a fibre first: an environmental and social standard for wool textile processing.

INITIAL POSITION

The market actually requires more and more engagement of manufacturers in Corporate Social Responsibility (CSR). The AWI licensees are operating worldwide and partly in countries classified as risk countries concerning environmental protection and social responsibility. Furthermore the

increasing pressure on retailers causes the importance of acting responsible in these areas.

More and more consumers are considering environmental and ethical aspects in their buying decision.

Media and non-governmental organisations are increasing pressure to improve working conditions particularly in developing countries and emerging markets.

AWI intends to provide its licensees with sustainable management solutions within the Merino supply chain leading the participating companies to a premium level of product quality, environmental and social top level compliance with global requirements. The licensees shall have the ability to meet laws, directives (e.g. REACH/RoHS etc.) and customer specifications based on a proactive approach.

The final goal should be a premium signet under ethical and sustainable principles.

The CSR mission statement:

“The Woolmark Australian Merino brands mean more than just premium quality, they mean the product exceeds ethical and environmental best practice from the Australian environment to the consumer. Consumers will buy Australian Merino for two reasons: for themselves and for the environment”



AWI works in a number of markets, this gives us a unique ability and reach.

For example another supply chain initiative includes linking a Japanese brand Onwards to the Australian farming community. Onwards have contributed money towards developing on-farm best environmental practices. In this case Australian Landcare Management





Systems (ALMS).

Onwards utilised AWI's non-profit status to contribute 10 million Yen directly to extension work in the Australian Outback.

AWI also works on sustainability in other wool growing countries. For example: wool harvesting expertise transfer to remote and pastoral China peasant households: 2006-09

From 2006 to 2009 AWI worked with the Chinese and Australian government agencies and local companies to improve the returns for Chinese peasants via better wool harvesting methods.

AWI also donated blankets during the aftermath of the terrible Sichuan earthquakes in April 2008 which claimed the lives of 80,000 people and left many more homeless.

FUTURE CONSUMERS

The Merino dichotomy: tradition and evolution, youth and beauty

- One of the earliest depictions of a Merino. "El Buen Pastor" (The Good Shepherd) circa 1650 by Murillo (Spain)
- One of the latest knitwear pieces on a catwalk in New York. circa 2008

Fibre use trends

Looking forward, the market picture is challenging for wool and for other fibres.

Growth in the consumer market for textiles is slowing in both developed and developing countries.

Consumer spending per capita is moving away from clothing to housing, transport and education.





When apparel is purchased, consumers and retailers want better value in terms of price and quality.

New synthetic fabrics are competing on both lifestyle performance and cost points.

Major influences on demand for apparel textiles and wool into the 21st century have been identified:

The global apparel market is projected to grow at 2.5 per cent per annum - below the rate of expected four per cent world GDP growth.

The largest clothing sector will continue to be casual leisurewear (70 per cent) though its share will decline a little as 'smart casual clothing', sports apparel and active leisurewear segments develop.

Overall, the consumer wants it all. Key Apparel Purchase Drivers are no longer fashion designers but practical consumer demand for:

- Casual looks - relaxed, less structured but not cheap or uniform fabrics
- Comfort - looser fit, lightweight, soft handle, breathability and stretch
- Clothes that travel well - wrinkle resist, durable
- Convenience - total easy care
- Versatility - multi-occasions, seasons, individuality
- Value for money - a genuine product difference or a cheaper product
- Lifestyle brands - especially for young people, with confirmation of 'branding' as a global trend.

Retail consolidation with the aim of forcing economies of scale, and so lower margins and consumer prices, will increase buying pressure on apparel. Prices will continue to fall in real terms for many basic apparel categories.

The textile supply chain will have fewer players with access to consumers and more emphasis on value for money, product innovation, exclusivity, strategic alliances for co-operative product development, linked international expansion, global sourcing and promotion.

Pressures on wool prices and costs will continue, with ups and downs. The forces reducing prices paid for apparel and textiles include: - consumer spending choices away from clothing, consumers seeking best prices, oversupply of fibre and excess processing capacity, retail competition, global manufacturing competition locating into lower cost countries, and falling trade barriers for suppliers and markets.

Price and product demands are eroding the market share held by natural fibres. Greater economies of scale and industrial investment in new technology for synthetic fibres - polyester, acrylic and nylon - have enabled volume growth through price discounting, particularly in Asia

Future consumers

Young people dominate discretionary apparel expenditure globally. Young adults stress price and performance rather than textile fibre. They associate natural fibres with quality, but branded 'performance' products are further increasing the appeal of man-made fibres

(Tencel®, wool-like Polartec®, Lycra®).

Younger adults have high regard for wool quality, softness and breathability - however 50 per cent see wool as difficult to care for and 42 per cent think wool apparel is itchy. Both consumers and retailers perceive that wool is used for formal wear and classic knitwear for older people.

AWI invests in the development new wool blends, fabrics and textiles to address these consumer concerns.

Product pricing will continue to influence younger and older consumers, retailers and pipeline businesses with the option to use fibre alternatives. Wool is an expensive fibre to produce and to process compared to cotton or synthetics. AWI is committed to research, development and innovation that will reduce costs and improve production efficiencies at each stage of the global wool pipeline.

Cotton Incorporated: New Innovations for Cotton Products

Rachel Crumbley, Cotton Incorporated, USA

Cotton Incorporated, funded by U.S. growers of upland cotton and importers of cotton and cotton textile products, is the research and marketing company representing upland cotton. The Program is designed and operated to improve the demand for and profitability of cotton through research and promotion.

Cotton Incorporated has developed many innovative technologies for cotton and continues to bring these technologies to the global product supply chain.

The STAY TRUE COTTON technology helps indigo-dyed and tinted denim retain their original color, longer. Denim garments finished with the STAY TRUE COTTON technology retained 93% of their original depth of color after 25 home launderings, compared with about 80% in untreated garments. And since the finish helps retain dyes and tints, less of these are released through home laundering, giving STAY TRUE COTTON garments an environmentally friendly appeal.

The STORM DENIM™ finish from Cotton Incorporated is a super repellent treatment that protects The wearer from moderate rain, snow, and wet conditions while maintaining the natural comfort and breathability of cotton.

STORM DENIM technology offers multiple benefits. Consumers can stay comfortable because jeans treated with this technology are as soft and easy to wear as regular denim. All of the great styling effects that make denim unique are preserved because this finish can be applied in garment form. The STORM DENIM finish will boldly take denim into a new category and introduce consumers to “performance jeans”. Finally, this innovation helps to repel everyday stains and provides an extra level of durability, making them ready for whatever the day may bring.

The WICKING WINDOWS™ is a moisture management technology for cotton that transfers moisture away from the body, reduces absorbent capacity for faster drying and reduces fabric cling.

Cotton fabrics generally wick well and typically absorb much more moisture than synthetic fibers. It is this characteristic that has limited cotton’s ability to perform well in activewear and performance apparel end uses. Through new advances in technology, cotton can be engineered to transfer moisture away from the skin to the outside of the fabric, keeping the wearer dryer and more comfortable. Fabrics treated with the WICKING WINDOWS technology are less absorbent so they not only cling to the body less, they also dry much faster during and after exercise.

Many synthetic fabrics claim to move moisture from the inside of the garment to the fabric’s outer layer, however most do nothing more than effectively absorb perspiration and trap as much moisture next to the skin as is moved through the fabric to the outside of the garment, leaving the wearer damp and uncomfortable. Directional movement of moisture can now be quantified through measurement of a fabric’s Accumulative One-

Way Transport Index. This index value is measured by the MMT Apparatus from SDL Atlas. The performance of a fabric when subjected to this test is directly related to one-way movement of moisture through a fabric structure and away from the skin. Cotton

Fabrics treated with the WICKING WINDOWS technology show a 1400% improvement in one-way transfer of moisture to the outside of the fabric over their untreated cotton equivalent. Most synthetic fabrics also achieve a rating similar to untreated cotton, showing very little or no one-way movement of moisture. During exercise, many fabrics can become overly-saturated with perspiration. As the body moves, friction is created between the skin and fabric. Because most wet fabrics tend to cling to the skin, irritation or chafing can occur. Cotton fabrics treated with WICKING WINDOWS technology have demonstrated significant reductions in the amount of cling force next to the skin when wet, meaning no irritation or discomfort during exercise. Cotton fabrics treated with WICKING WINDOWS technology also exhibit the ability to dry much faster than untreated cotton. This is not only a benefit to the wearer, as fabrics dry faster through evaporation during exercise, but also dry faster afterwards. This ability to dry faster provides an additional benefit to consumers as it translates to much less energy consumption during home laundering and drying.

Cotton Incorporated has recently unveiled its advanced TransDRY™ moisture management technology, an innovative new system that enables the production of quick-drying, engineered fabrics for performance apparel.

Cotton fabrics made with TransDRY technology offer cotton's familiar comfort and softness while staying dry, keeping the wearer cooler and more comfortable. That's because they're engineered to transfer moisture in one direction, away from the skin to the outside of the fabric, where moisture can evaporate.

The TransDRY™ brand, named for its unique ability to quickly transfer moisture away from the skin and dry faster, raises the bar for cotton performance and will set a new standard of high-performance moisture management.

In an effort to make the textile supply chain more environmentally friendly, Clariant International, Ltd. and Huntsman have recently developed and optimized new exhaust bleaching procedures for cotton. Tests and evaluations at Cotton Incorporated indicate that the new procedures conserve water and reduce processing time, lower energy consumption and lessen the chemical impact of conventional bleaching, while yielding comparable results for fabric whiteness, absorbency and fabric physical properties. These improvements can be achieved using existing batch machinery and require no additional capital expense for implementation.

Traditional 3-stage bleaching involves desizing, scouring and bleaching, but a new technology developed by Innova International combines the desizing and scouring stages in one step. That's not all: It significantly reduces the number of wash boxes following both the desize and the bleach. Water and energy use are reduced by more than 60%, since there's less hot rinsing and less time in the steamer, which translates into higher productivity. And there's comparable whiteness and fabric strength to conventional preparation of the fabric. Cotton Incorporated worked with Innova International and its president, Angelo Rizzardi, inventor of the process, in the very early development stages, using its expertise, labs and equipment to optimize the process. Rizzardi comments, "Of the water used in textiles, 80% to 85% is consumed in wet processing, so it needs to be addressed if we want sustainability in the textile industry. We may end up saving probably 70% or more of water that currently is wasted or used in the rinsing operation. A similar amount of energy will no longer be necessary to heat water to the necessary temperature."

Annex I: Programme

Keynote address: Non-food agriculture and the bio-based economy – agricultural production of fibre, energy, materials, and others. What is the future of fibre production in agriculture? (*John Williams, National Non Food Crops Centre, UK*)

Natural fibres and the environment – environmental benefits of natural fibre production and use

(*Jan van Dam, Wageningen University, The Netherlands*)

Natural fibre production and food security – significance for poverty alleviation and employment: Regional focus

Jute in South Asia

Rezaur Rahman, *Bangladesh*

Cotton in West Africa

Karim Hussein, *IFAD, Rome*

Sisal: Small farmers and plantation workers

David Machin, *UK*

Wool and other animal fibres in Latin America

Roberto Cardellino, *Uruguay*

Natural fibres in China

Zhang Jianchun, *Chinahemp, Beijing*

Coir in Asia

Romulo N. Arancon, *APCC, Jakarta*

Recent and current developments:

Technological development, R&D: What has been achieved in recent years (including cooperation with CFC), what has been achieved with new markets, new non-traditional applications, what are the priorities for the future?

Industrial Fibres

Brett Suddell, *ADAS, UK*

Wool

Ben Lyons, *AWI, Australia*

Cotton

Rachel Crumbley, *Cotton Inc, USA*

Panel Discussion: What actions are required to ensure a sound future for natural fibres? Where are the bottlenecks: government policy? Technology? Market constraints? Trade barriers?

International Year of Natural Fibres 2009: proposals for action

Annex II: List of participants

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