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A report on
The International Workshop

**Development of Natural Polymers and Composites in
East Africa**

Held at
Impala Hotel, Arusha, Tanzania
25 – 27 September 2000



Organized by
**Tanzania Industrial Research and
Development Organization, Dar es Salaam,
Tanzania**



In collaboration with
**International Centre for Science and High
Technology, Trieste, Italy**

Sponsored by



the United Nations Industrial Development Organization
Vienna, Austria

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**PLEASE BE AWARE THAT
ALL OF THE MISSING PAGES IN THIS DOCUMENT
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ACRONYMS

ARCEDEM	African Regional Centre for Engineering Design and Maintenance
BRU	Building Research Institute
CMRDI	Central Metallurgical Research and Development Institute
CNSL	Cashewnut shell liquid
HABITAT	United Nations Human Settlements Organization
IAEA	International Atomic Energy Agency
ICS	International Center for Science and High Technology
IDRC	International Development Research Centre
JICA	Japan International Cooperation Agency
KEFRI	Kenya Forestry Research Institute
TANITA	Tanzania-Italia Cashewnuts Processing
TIRDO	Tanzania Industrial Research and Development Organization
TWAS	Third World Academy for Sciences
UF	Urea formaldehyde
UNCST	Uganda National Commission for Science and Technology
UNDP	United Nations Development Programme
UNIDO	United Nations Industrial Development Organization
WAITRO	World Association of Industrial and Technological Research Organizations
WIPO	World Intellectual Property Organization

ACKNOWLEDGEMENT

Tanzania Industrial Research and Development Organization (TIRDO) would like to express gratitude to all individuals and institutions who contributed towards the success of the foregoing Workshop, from early stages of preparation to successful conclusion.

First, TIRDO is thankful to the United Nations Industrial Development Organization (UNIDO) who sponsored the workshop. Next, the Managing Director and staff at the International Centre for Science and High Technology (ICS-UNIDO) whose New Materials unit under Professor Meriani, not only initiated the project, but also gave all manners of support for its success.

Our acknowledgement to the management and staff of the Impala hotel, which offered a convenient, well equipped venue for the workshop.

The organization is indebted to the Guests of Honour, Mr Daniel Ole Njoolay, the Arusha Regional Commissioner, who launched the workshop; and Mr Felix Ugbor, resident country representative, who officiated the closing: their remarks, contained in this report, gave a challenge to all participants and their countries.

Sincere thanks should go to all participants of the workshop. Their acceptance to attend the workshop despite their tight schedules made the workshop a success. The papers presented and all positive contributions as shown in the "Workshop Recommendations" section are the nucleus of biocomposites development in the East Africa region. M/S Sakina Brick Works permitted the visit by the whole group of participants to their production facility. We are grateful for their co-operation.

Lastly, TIRDO is acknowledging the tireless work done by the organizing committee during preparation, workshop sessions and post workshop activities.

EXECUTIVE SUMMARY

The international workshop *Development of Natural Polymers and Composites in East Africa* was organized by Tanzania Industrial Research and Development Organization (TIRDO) in collaboration with the International Centre for Science and High Technology (ICS-UNIDO) under the sponsorship of the United Nations Industrial Development Organization (UNIDO). It was held at the Impala Hotel, Arusha from Monday 25th to 27th of September 2000.

The workshop was attended by 24 participants (Annex 2) from Italy, the Netherlands, Kenya, Namibia, Tanzania, Uganda and Zimbabwe. The workshop objectives were to promote research and application of natural polymers and resins in the development of engineering materials for use in the construction industry.

Arusha workshop activity was carried out successfully and a total of 21 papers were presented. All papers were discussed in depth and both the authors and the audience made developmental contributions. From the participants' observations there were some specific recommendations, which include:

- the need to establish the "Materials Research Forum" for exchange of information amongst scientists and technologists in the region
- to carry out a tracer study for region's materials scientists
- establishment of the "Building Materials Council" for East Africa, which will later become a focal point to enforce implementation of resolutions as well as serve as a base in looking for resources—human, financial and so forth
- development of resins and composites human resources in the region
- project on a database of human resource, equipment, building materials production units and research capacity in East Africa has already been initiated, and should be carried on and improved upon; and
- characterization of biocomposite materials to provide properties for design purposes

These recommendations made a reference for future work to the promotion of biocomposite technology in the East Africa sub region.

PART ONE: SCIENTIFIC REPORT

1.1 Introduction

This report describes in details all stages working towards the workshop, the conduction and post workshop tasks. Besides being the comprehensive summary of the project activity, it is also expected to be a good template for anyone organizing a similar activity in future.

1.2 Preamble

1.2.1 The ICS-UNIDO Project

The International Centre for Science and High Technology (ICS) is located at Area Science Park in Trieste, Italy. The Centre operates under the aegis of the United Nations Industrial Development Organization (UNIDO) and under the guidelines of the Italian Ministry of Foreign Affairs. The Strategic goal of ICS is to advance the Industrial competitiveness and investment climate in developing and emerging countries. These objectives are met by ICS through its four operating areas namely: Pure & Applied Chemistry; Earth, Environment & Marine Sciences & Technology; High Technology & New Materials and Technology Services.

Arusha workshop was executed under New Materials sub programs which aims at integration of by products as secondary raw materials and the use of renewable materials for the development of low-cost building materials. New Materials subprogram for the East Africa region was a result of an Expert Group Meeting on "Composite Materials and Waste Minimization" that took place in Trieste, Italy from 13th – 15th November 1996. The Expert Group Meeting, among other activities, planned an international workshop on "Composite Materials Based on Natural Resources" which took place in Dar es Salaam, Tanzania from 4th – 8th August 1997. Dar es Salaam workshop was followed by

another workshop on “Materials Selection and Design for Low-Cost Housing in Developing Countries” Trieste, Italy 16th – 20th November 1999. The last workshop recommended for a regional (East Africa) project whose objectives were specified to be “to design, develop and manufacture composites based on locally available natural resources aimed at assembling of economically competitive building materials”. The goal was to be achieved through international cooperation between the institutions, industries and research centres in these countries and in Europe. The Arusha workshop was therefore proposed as an initiative to provide a platform for regional members to brainstorm strategies for fulfilling this goal. An overview of the activities, in an inaugural paper by Professor Sergio Meriani, the ICS-UNIDO Consultant, appears in Annex 11.

ICS identified the Tanzania Industrial Research and Development Organization (TIRDO) as the host and subcontractor to the Arusha workshop activity. TIRDO was selected based on the existing cooperation and due to the role the organization plays to Tanzania's industrial development.

1.2.2 The host, TIRDO

Tanzania Industrial Research and Development Organization (TIRDO) is a governmental research institute that was established by the Parliament Act No. 5 of 1979 and it became operational on 1st April 1979. Basically the Organization was set up for the purpose of conducting industrial research and to offer consultancy services to the Tanzanian industry. The core of TIRDO operation is to promote indigenous technology and raw materials utilization in economic ventures.

The Organization is mainly involved in carrying out industrial research for the purpose of developing products and processes suitable for the Tanzania industrial environment. In this regard, the emphasis is to promote the use of indigenous raw materials that

can be processed using equipment that is mostly fabricated by local workshops. Based on the technology developed, entrepreneurs are consequently assisted to commence production using the plants following field trials.

Technologies that have been developed among others by TIRDO some of which have been commercialized, include:

Production of Tannin based Wood adhesives applicable in the manufacturing of particleboard and plywood. The adhesives' superior characteristics in application are due to being water-resistant even after boiling, and resistance against microbial attack. In collaboration with the University of Dar es Salaam, TIRDO is investigating the use of the developed glue to produce chipboards using agrowastes such as coffee husks, rice husks and coconut (fibre) husks. Also in collaboration with Tanzania Pesticide Research Institute, TIRDO is evaluating the anti-fungal and termite attack properties of cashew nut shell for treatment of wood poles and natural composites.

Production of natural dyes from the barks of mangrove trees; Production of caustic soda from lime and lake Natron magadi soda using the Gossage method; Production of sodium alginate from brown seaweed (*Sargassum* species); Production of school chalk based on local gypsum and related industrial wastes; Essential oils and perfume production from indigenous aromatic plants; Turkey red oil from castor oil used as wetting agent in textile manufacturing; Furfural and furane resins from bagasse, and other agro wastes.

TIRDO provides technical support to the Tanzanian industry through consultancy in such areas as:

- chemical analysis and food microbiology analysis;
- materials testing—physical and non-destructive testing;
- industrial energy management;

- cleaner production in industry; machining welding, design and fabrication;
- troubleshooting and industrial instrument maintenance;
- industrial information and advisory services.

On its own capacity or in collaboration with international organizations TIRDO organizes a number of training courses, workshops and seminars. These programs are aimed at upgrading knowledge and skills to the indigenous industry's technical personnel and it is also aimed at dissemination of research and development outputs to the stakeholders.

TIRDO is collaborating with international institutes such as United Nations Industrial Development Organization (UNIDO), United Nations Development Programme (UNDP), International Development Research Centre (IDRC), World Intellectual Property Organization (WIPO) and Third World Academy for Sciences (TWAS). Others are World Association of Industrial and Technological Research Organizations (WAITRO), the Central Metallurgical Research and Development Institute (CMRDI) and Japan International Cooperation Agency (IAEA). Some of the training courses and workshops carried out are:

- Seminar on management of technology, 17th – 22nd September 1990 (with WAITRO)
- Workshop on administrative and financial management for managers of research and development institutions in Tanzania, 2nd – 7th April 1995 (with IDRC)
- Workshop on popularization of patented information of value to entrepreneurs, November 1995 (with IDRC).
- Sensitization seminar on the role of industrial information on sustainability of economic ventures, 30th – 31st January 1997.
- Professionals Training in Welding Technology Level 1. 22nd Nov. – 3rd Dec., 1990 (with CMRDI and JICA)

- Group Training Course in Mineral Ore Beneficiation. 13th – 24th March. 2000 (with CMRDI and JICA)
- Professionals Training in Ultrasonic Testing Level 2, 27th March – 7th April 2000 (with CMRDI and JICA).

Other Seminars and training courses are such as Energy Management (with UNIDO); Non destructive testing of concrete structures, materials testing, (with IAEA); Certification of welders and instrumentation.

1.3 Preparation

1.3.1 Call for papers

Those who had participated in the past workshops were the first to be contacted to submit abstracts if they had some progress or break through to report. These comprised researchers (from research and academic institutions) and industrialists. The largest proportion was to come from Eastern Africa, in accordance with the workshop theme.

Another approach used was to contact heads of institutions that were involved with S&T to nominate suitably qualified participants. Institutes contacted included Uganda Council for Science and Technology (UNCST) and Kenya Forestry Research Institute (KEFRI).

The contacts were made by TIRDO, first calling for abstracts and résumés of would-be participants also as a basis for selecting participants.

1.3.2 Proposal to UNIDO for Funding

While TIRDO had been communicating with individuals and institutions, ICS had initiated preparation of a proposal to be submitted to UNIDO Headquarters in Vienna for funding of the

workshop. TIRDO supplied a tentative budget; main budget elements being travel costs, participant allowances and venue costs. That budget is included in the Part Two of this report, the Financial Report. The proposal, submitted early June 2000, was approved by July with a budget of USD 34,000. Therefore, allowed organizers to make invitations and various reservations to meet proposed dates. Amid a flurry of activities that followed, the contract document was sent to TIRDO by UNIDO, signed and returned to Vienna. 80% of the money was then transferred into the TIRDO account immediately thereafter; the remaining would be remitted upon successful completion of the activity, marked by production of the Report.

1.3.3 Selection of participants

The workshop was planned for 25 participants, including those from the EA sub region and a few from Europe. As the number of candidates was higher than the available chances, a selection process was necessary.

TIRDO formed a technical committee to look into candidates' technical matters. This committee went through and evaluated the abstracts as well as résumés (Annex 4) sent in.

Rating criteria were

- (i) involvement in biocomposite research
- (ii) originality of the paper
- (iii) contribution of paper to scientific knowledge
- (iv) for industrialists, work with polymers, resins and biocomposites.

While most of the abstracts submitted were quite admissible, the organizers endeavored to cover a wide spectrum within the workshop theme—that is, where two or more papers were on a closely related subject, only one of them (better by rating criteria) would be selected.

1.3.4 Venues for Workshop and Industrial Visit

The town of Arusha

Arusha, a municipality in Northeastern Tanzania, is attractive choice for hosting international workshops. An alternative would have been Dar es Salaam, the commercial capital of Tanzania, on the shores of Indian Ocean. Settling for Arusha was influenced by a number of factors, including

- The weather at the timing of the workshop was much better in Arusha, which is located at a high attitude
- The hotels with conference facilities are not only well equipped, but are also less costly compared to those in Dar es Salaam.
- There is a direct flight to and from most destinations the participants would be travelling.

Hotel for Workshop venue

The hotel chosen for the meeting, the Impala Hotel, had the conference facilities as well as the accommodation. As the rates were reasonable, most participants elected to stay there, much to the convenience of attending the sessions on time. The other positive attribute of the hotel is, it is located in the suburbs, and therefore quieter and away from town center racket. It also possesses good telecommunication facilities including access to the Internet.

Industrial visit

There was to be an industrial visit relevant to the workshop. M/S Sakina Brick Works—a company specializing in production of burnt bricks, located within 30 minute drive from Impala Hotel—granted permission to have participants visit their factory during working hours on day two.

1.3.5 Programme

After selection of participants, invitation letters were sent out to the successful candidates; and these were asked to submit their papers, preferably in electronic form (as email attachments or on diskettes). It is worth remarking at this point that the computer – based communication that was used at all stages of the workshop was a big money and time saver. In deed, as almost all participants had access to email, by the time of the secretariat traveled to the workshop venue, they had in hand most of the participants' papers; edited to the preferred format and reading for distribution.

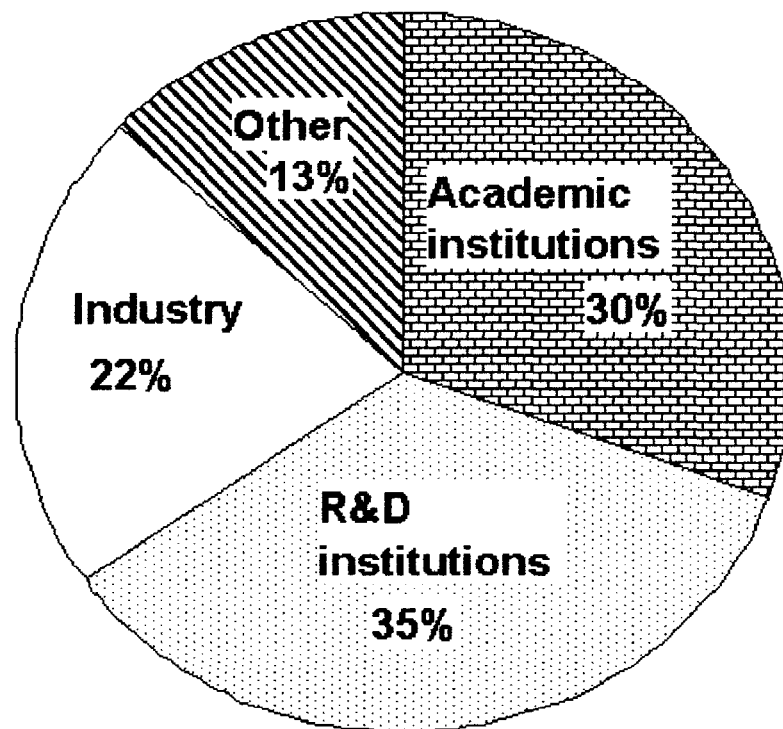


Fig. 1: Composition of participants

On top of email communications, the organizers also mounted workshop information on the TIRDO website (www.sdnf.undp.org/tirdo), where abstracts, programme and other information could be located with ease.

Through communication with ICS the tentative workshop programme was drawn up. For effective conduction, the papers

were divided into four sub Themes; namely Design, Building Materials, Biocomposites/Resins and Research/characterization.

The workshop would run for three days, beginning 25 September 2000. The fourth day would be that for the secretariat/organizers to meet and reflect on the workshop just concluded annex III.

The programme was arranged such that each presenter had about 30 minutes to make a presentation, which was followed by 30 minutes of discussion. A typical day had two to three sessions each chaired by a different person. On day 2 of the workshop an industrial visit had been arranged. The participants visited M/S Sakina Brick works, involved in product of fired bricks, a major building material in many parts of the East African sub region.

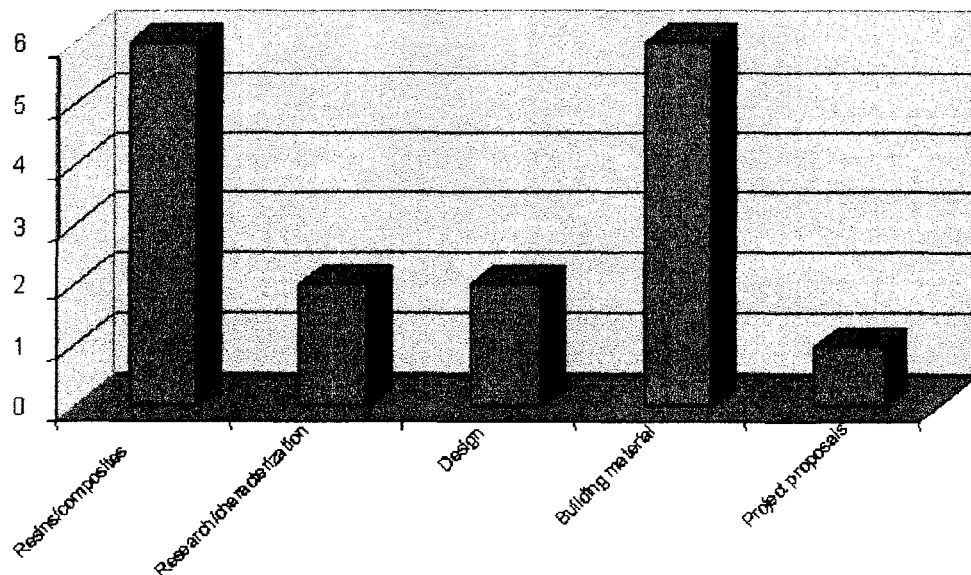


Fig. 1.2: Distribution of papers by category

1.4 Opening

The opening ceremony was officiated by the Arusha Regional Commissioner (RC), Mr Daniel Ole Njoolay.

In the opening speech (Annex 9), he noted the international setting of the group, and pointed out that he hoped that they would all pool and share their expertise and experiences. He also said that he expected the workshop to encourage entrepreneurs in the East Africa sub region to invest in production of cheap building

materials from the technologies developed by the experts, some of whom were attending this workshop.

In line with Human Settlement Development Policy of Tanzania, the RC indicated five criteria for choice of technology to pursue: one, use of locally building materials with means that were available and/or appropriate to a given locality. Two, encourage use of appropriate technologies. Three, use mechanization where it increased efficiency without compromising job opportunities. Four, incorporate local qualified enterprises when Government is awarding contracts. And, five, encourage use of locally produced building materials in public houses construction.

The Guest of Honor also recognized the contribution of local R&D institutions in the area of biocomposites research, such as the TIRDO wood adhesives project, which went to as much as being used in industrial production of particleboards.

He paid tribute to the UNIDO for financing the workshop, ICS for coordination effort, in particular Professor Meriani, the New Materials Consultant with ICS; also the various institutions who granted leave to participants for attending the workshop and industrialists who broke their busy schedules to come to the workshop.

1.5 Scientific sessions

All the workshop days were divided into 4 sessions, separated by tea and lunch breaks.

The first session of day one was special, dedicated to opening ceremony and registration. The last session of day three was set for compiling recommendations and closing ceremony.

Following is a day-to-day account of the technical sessions. The program appearing in Annex 5 has the schedule of papers presented, and abstracts for all papers appear in Annex 3.

1.5.1 Day One

The first session commenced after tea break following the official opening. Dr G Kawiche chaired it. Four papers presented by Prof E Bisanda, Eng W Tabaaro, Mr N Kumar and Mr J Githiomi. Mr R Nindie was a rapporteur for this and subsequent sessions of the Workshop.

Dr U Ferri, Dr A Shirima and Prof Y Kaahwa made three more presentations in the following session, under Prof Bisanda's chairmanship.

The last session of the first day sat for two presentations, the first by Mr Makundi and Mr Nindie, and the other by Dr Kawiche.

1.5.2 Day two

Dr A Nanyaro chaired the opening session of the day, with two papers by Mr W Ogola and Mr E Dyauli. The two subsequent sessions chaired respectively by Prof Kaahwa and Prof Meriani sat for presentations by Mr J Onchieku, Mr B Ndazi and Mr J Mallya; and for the third session of the day, Professor Bisanda and Dr Nanyaro. This afternoon session had Professor Meriani as chairman.

The last session of day two was dedicated to industrial visit. The site chosen for the visit was M/S Sakina Brick Works Company, a small enterprise located some 10 kilometre from Arusha town.

The visit went well. Discussions during the visit and afterwards were lively, as that factory demonstrated how easy it was to set up such a facility to produce low-cost building materials. Red soil is abundant in the East Africa sub region and firewood used for firing is negligible compared to wood that is utilized in building the common adobe-and-poles houses: the latter also lack the durability, aesthetics and strength of a house built from burnt bricks. Production of red bricks requires little investment, as long as there is a source of suitable clay in the neighborhood.

This setup, therefore fitted well within the Workshop objective, that of demonstration of production of cheap housing material with minimal inputs in terms of investment capital, machinery and skilled manpower.

1.5.3 Day Three and Four

In the third day the first session chaired by Dr Kawiche had two papers, with Mr H Sithole and Mr L Wilson as the presenters.

The second session, under Prof Kaahwa, received the last three presentations, from Prof P Kandachar, Dr E Elisante and Dr B Ahmed.

When the group reconvened after lunch the special session of making observations, drawing recommendations and coming up with project proposal concepts for future took place. The list of observations and recommendations made appear in Annex 8.

On day 4 the organizers met to assess the various matters pertaining the Workshop, including

- looking at evaluation questionnaire outcome
- charting out *modus operandi* towards successful production of report
- preparation of proceedings
- handling concluding tasks such as settling of bills for rented equipment etc.

1.6 Closing

The UNIDO Representative for Tanzania and Malawi, Mr Felix Ugbor officially closed the Workshop. Before he made the closing speech, Dr Nanyaro made a welcoming speech and Prof Meriani made a short remark on behalf of ICS. The speeches are included in Annex 9.

In the closing speech, he observed that the issues raised in the workshop were relevant and timely, regarding use of polymers and resins in production of building material. He mentioned that the

issue of decent shelters was of interest in the nation, featuring examples of meetings and exhibitions to that effect in recent past.

He observed smugly the high expenditure of African countries in importing building materials, saying that technologies developed such as the ones presented in the foregoing meeting should be promoted and marketed to meet some requirements.

He observed that the policy makers did not form part of participants, something that ought to be considered for future workshops.

He observed the regional setting of the workshop, and said it was good, as the participating countries would be sharing experiences.

1.7 Evaluation

On the day three, the participants were asked to complete an evaluation questionnaire (Annex 6) which was to provide feedback to organizers and sponsors. As the respondents were not asked to write their names on the questionnaires, the responses are considered frank and unbiased.

On organization of the workshop, a majority felt that it was organized very well. The majority considered the programme, from the scientific content point of view very good.

Most participants felt that the number of days for the workshop and the lengths of working days were just right.

On the average, the participants thought the hotel; meals and conference facilities were very good.

Different participants gave their opinions on a range of issues, including establishment of biocomposite research databank for the East Africa sub region; promoting and marketing the successful research results on cheap housing material and so forth. The summary of responses to the questionnaire of Annex 6 is included in Annex 7.

PART TWO: FINANCIAL REPORT

The budgeted expenditure was USD 34,000. The organizers made effort to work within this figure, and although actual expenditure of different items differed from budgeted figures, the variations managed to add to a net effect of almost precisely the budgeted figure.

Annex 10 has the signed financial statement. The tables below have actual expenditure and budgeted expenditure.

Table 2.1: Budget (in USD).

#	ITEM	DESCRIPTION	Qty	@	Total
1	Travel expenses— European participants	4 participants	4	1,375	5,500
2	DSA 6 days	4 participants, 6 days	24	125	3,000
3	Travel expenses – African participants	21 participants	21	450	9,450
4	DSA 5 days	21 participants, 5 days	105	125	13,125
5	Conference venue	Lecture hall and facilities, 4 days	4	250	1,000
6	Technical visits to factories	1 visit, local transport, 1 day	1	300	300
7	Consumables	Stationery and printed materials for presentation		725	725
8	Telecommunications	Telephone, fax and e-mail services			400
9	Secretarial support	Organisational costs, 2 man months			500
					34,000

Table 2.2: Actual expenditure (in USD).

	Description	Unit	Qty	@	Cost
1	Travel Europeans	Each	3	1,340	4,020
2	Travelling regional	Each	20	535	10,700
3	DSA	Man-nights	108	125	13,500
4	Conference venue	Days	4	250	1,000
5	Visits	Days	1	310	310
6	Consumables			1,580	1,580
7	Telecoms			480	480
8	Secretarial support	Man-months	3	800	2,400
					33,990

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Annex 1: Press release**SHIRIKA LA UTAFITI NA MAENDELEO YA VIWANDA TANZANIA***Tanzania Industrial Research and Development Organization*

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10 September 2000

PRESS RELEASE

Tanzania Industrial Research and Development Organization (TIRDO) in collaboration with the International Centre for Science and High Technology of Italy (ICS-UNIDO) and under the aegis of the United Nations Industrial Development Organization (UNIDO) is organizing an international workshop on "Development of Natural Polymers and Composites in East Africa". The workshop will take place at Impala Hotel, Arusha, Tanzania from 25 – 27 September 2000.

The Prime Minister of the United Republic of Tanzania, Mr. F.T. Sumaye (MP) will officiate the workshop on 25th September and Mr. F. Ugor, the UNIDO resident representative in Tanzania, will close it down on 27th September*.

23 technologists, researchers, academicians and entrepreneurs from Italy, Kenya, Namibia, The Netherlands, Tanzania, Uganda and Zimbabwe are expected to attend the workshop. The Workshop participants will, among other activities, brainstorm ways of promoting the development of composites from natural resources for various uses including housing applications.

Workshop details can be viewed at TIRDO and ICS-UNIDO web sites, www.sdnf.undp.org/tirdo and www.ics.trieste.it respectively.

T.K. Mahulu

For DIRECTOR GENERAL

* Due to unavoidable circumstances, the Prime Minister could not attend to the function, and instead the Arusha Regional Commissioner, Mr D Ole Njoolay opened the Workshop.

Annex 2: Participants contact information

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Annex 3: Abstracts

LOW COST HOUSING FROM NATURAL MATERIALS: THE CASE OF BAMBOO AND CLAY

Prof. E.T.N. Bisanda

The dream of low cost (affordable) housing has been floating on the African continent for many years now. However, it has not yet been a reality as most Africans continue to live in unhygienic and poorly constructed houses. Building materials continue to be expensive and unaffordable to the majority of our people. Africans seem to have forgotten the traditional materials they have been using for centuries before the coming of the white man (mzungu). This paper looks at the potential of natural resources such as bamboo forests and clay (earth) for the construction of modern but affordable houses, using modern construction techniques. Bamboo is seen to be a good structural material that can meet most of the structural requirements, for low cost but modern constructions. The adoption of compressed earth technology is seen to be a breakthrough for the provision of walling and flooring construction blocks and tiles, against the dependence on sand-cement and fired clay bricks that have proved to be expensive and environmentally unfriendly.

DESIGNING WITH NATURAL FIBRE COMPOSITES

Dr P V Kandachar

Natural fibres, such as flax, hemp, kenaf, have mechanical properties comparable to those of synthetic fibres like glass. But they are lighter, less expensive, and biodegradable and are easily available as agricultural resources in many countries. Composites fabricated using these natural fibres have the potential to be attractive alternative to synthetic fibre composites. The natural fibres, however, exhibit more scatter in their properties than synthetic fibres, are thermally less stable and are sensitive to moisture absorption. The choice of matrix to reinforce with these fibres therefore becomes critical.

Currently, synthetic non-biodegradable polymers, such as polypropylene, polyester, urea, melamine, are being explored as matrix materials, in sectors like automobiles and buildings. Biodegradable polymers, as alternatives to synthetic non-biodegradable polymers, if made available in sufficient quantities at affordable prices, pave way for bio-composites in future. With both matrix and fibres being biodegradable, bio-composites offer the maximum potential from the environment point of view.

Currently, extensive and reliable property data on natural fibre composites and/or on biocomposites, is lacking, making product design with these materials more complex than with fibre composites with synthetic matrix and fibres. However, once the database is made available, designing products with natural fibre composites and biocomposites offers several opportunities and challenges.

THE POTENTIAL OF COFFEE HUSKS AS WOOD SUBSTITUTE IN THE PRODUCTION OF PARTICLEBOARDS

W.O. Ogola, E.T.N. Bisanda, J.V. Tesha

Tanzania has her economy based on agriculture. The agricultural activities produce agricultural wastes that are mainly burnt in preparing the farms for the next season. This causes environmental pollution. Since its inception, the particleboard industry has been mainly relying on wood particles as the main constituent with synthetic binders such as urea formaldehyde, phenol formaldehyde and melamine formaldehyde as the binders. Wood is also used as a construction material and as a fuel source. Due to its vast applications in engineering and to mankind, wood has increasingly become scarce, consequently affecting wild life survival and destruction of the rain forests.

Research developments indicate that agricultural wastes, rich in cellulose could be used to produce useful engineering materials such as particleboards for furniture, partitioning and ceiling. This would not only reduce environmental pollution but also reduce the current pressure on wood.

Rice husks, bagasse, maize husks, maize cobs, coconut pith, groundnut shells, sunflower peels have been successfully used in making particleboards with synthetic binders such as urea formaldehyde and phenol formaldehyde.

Naturally occurring resins such as tannin, cashew nut shell liquid have been successfully used in particleboard manufacture obtaining outstanding mechanical and physical properties suitable for internal and external applications. They are cheap, readily available, in abundance and easy to process.

This research aims at using coffee husks, a by-product from coffee processing as the particles and hydrolyzed tannin and urea formaldehyde adhesives as the binder. Results indicate that coffee husks/tannin particleboards had higher physical and mechanical properties than the coffee husks/urea formaldehyde particleboards and that their properties compared well with other agricultural waste particleboards.

COMPOSITE ENGINEERING MATERIALS FOR THE BUILDING AND CONSTRUCTION INDUSTRY

Eng. Balu-Tabaaro

Increased world population is putting more pressure on housing. The ever-decreasing natural and traditional building materials whose cost of production has also gone up hamper the construction of housing. There is need to develop and promote alternative building materials. Composite materials based on local resources such as wastes from forestry, agriculture, agrobased industries, natural fibres, natural and artificial pozzolans etc. provide potential opportunity for alternative and renewable raw materials for low cost housing in Uganda and Africa.

The need for alternative housing materials based on composite materials is particularly important for Uganda and Africa in general. Large amounts of wastes from industry, mining and agriculture are produced in Uganda and Africa. These materials are of environmental concern and their disposal is expensive.

These materials are potentially useful in production of composite materials for low cost housing. Presently, a limited number of technologies are being developed to turn these wastes and natural fibres into useful building materials. The Research and Development is presently not well coordinated and well funded. There is need for more international agencies which are already well advanced in this field, to accelerate development of this sector.

This paper presents an overview of some success stories: study of available resources, the potential conversion of these materials into composite building materials, their production and the performance of new products. But there are still some gaps in the knowledge on production and technologies for their industrial production. There is also still lack of acceptance of these products by the population for field application that needs to be rectified through exchange of information.

Though some attempts have been made to transfer these technologies into Africa, the attempts have been isolated and have failed to create substantial impact in Africa. There is need to improve on the policy environment and technology transfer in the field of composite materials, through which an impact will be made. Such technology transfer is possible though interaction such as the one that will be held during a conference on " Materials Science" to be held at Makerere University in September 1999. Uganda and Africa's experience in this field will be presented to the conference. It is hoped that after deliberations, and mutual exchange of ideas, possible areas of collaboration and cooperation will be found to provide the development and use of composite materials for building and construction industry.

FUNCTIONALISATION OF CARDANOL WITH SOME REACTIVE MONOMERS

Marko Joksic, Massimiliano Franceschi, Federica Mantovani
and Ugo Ferri

The aim of present work is to study the synthesis of cardanol based thermoset resins for production of fibre reinforced materials like laminates, pipes etc. Our previous work was on Maleic Anhydride (MAA) reactions with Cardanol where anhydride groups were introduced to Cardanol based polymer. The present work is about introducing reactive vinyl groups to Cardanol, MAA – Cardanol polymer, Cardanol novolak polymer through substances like Glycidyl Methacrylate. By introducing the vinyl groups to the Cardanol polymer backbone we will be able to dissolve the solid polymer in a reactive solvent like styrene and thus obtain a low viscosity thermoset resin to be employed in production of fibre reinforced materials according to present technologies.

STANDARDIZATION AND VALIDATION OF TIMBER AND TIMBER PRODUCTS IN KENYA

Joseph K. Githiomi, Ben Chikamai and F. Mukui

Kenya has a national standardization body that develops standards and regulates the quality of various products. The standards on timber and composite products have been developed through the assistance of relevant Technical committees in reference to international standards and national standards. In Kenya, validation of the standard specification is done when new developments arise. There are various levels of standards that include company association (group standards), national and regional standards. The East African Region countries are in the process of harmonizing the regional standards to facilitate uniform specification products and services.

SOIL STABILIZATION WITH RESINOUS MATERIALS

Dr. G.M. Kawiche

The use of natural resins for the stabilization of various kinds of soil so as to improve their performance is of priority in the construction industry within East Africa and the world over.

Today more than 30% of the world's population live in houses constructed with soil. According to UNO, by 1987, the official demand of soil houses required per year in developing countries was above 500,000 units (200,000 in Latin America, 200,000 in Africa and 100,000 in Asia). Due to increase in population coupled by increase in poverty (in Tanzania 36% of the 50% of the population who are poor have an income below the US. \$ 31 per month), the shown figures are higher now. The application of affordable stabilized soil in the construction industry could assist in alleviating poverty.

The paper analysis, first the theoretical approach of the use of natural resins in soil stabilization, then areas of its application within and outside the construction industry and finally some initial results obtained from BRU Laboratories. It is open for discussion and subsections to be followed by joint research plans with other research Institutions.

PROPERTIES AND APPLICATIONS OF UGANDA KAOLIN

Prof. Yusto Kaahwa

The mechanical properties of kaolin samples from two main deposits have investigated. Dielectric properties and electric breakdown have also been studied in the high voltage range. The effect of particle size, compaction pressure and sintering temperature on mechanical and electrical properties have been investigated.

The results show a strong dependence of the mechanical properties on particle size, compaction pressure and sintering temperature. Applications of kaolin in the paint industry are described and other possible applications are discussed.

POTENTIAL PLANT FIBRES AND PLANT RESINS FOR THE MANUFACTURE OF LOW COST HOUSING MATERIALS IN KENYA - AN OVERVIEW

J. M. Onchieku and J.K. Githiomi

Kenya is generally an agricultural country with the sector contributing well over 80 % of its gross domestic product. The country produces large quantities of agricultural/forest wastes and residues that have enormous potential for use in the manufacture of various biocomposite materials for low cost housing. Their are however constraints to their exploitation the main being lack of an inventory of the renewable resources which could facilitate research and developmental undertakings which could also lead to full commercialization of insulating materials for low cost housing projects within the East African region. In Kenya attempts have been made to develop biocomposite materials from plant fibres

and plant resins at small scale levels with limited success. However much more basic and applied research need to be carried out if full commercialization of some of the technologies tested have to be implemented. This paper gives an overview of the current housing materials used, their limitations and suggests alternatives. It also looks at the opportunities available for the exploitation of renewable plant fibres and resins.

INDUSTRIAL PRODUCTION FOR ROOFING MATERIALS USING LOW-COST HYBRID COMPOSITES

D Jage and H Sithole

Observations show that the two roofing products produced within Zimbabwe (concrete and asbestos cement sheets) are cement based and as such, are increasingly becoming unaffordable to the majority of the population.

Observations backed by survey also indicate that the country is richly endowed with millions of tons of industrial and mine wastes which have potential as construction materials.

Research and development (R&D) work towards the development of a technology for producing roofing materials using low-cost hybrid composites thus, has its basis and context on the following factors:

- ◆ Cost of roofing is the single largest proportion in low-incoming building projects in the country.
- ◆ Almost all roofing materials available in the country (concrete tiles, asbestos cement sheets, MCR tiles) are cement based. An increase in the price of cement leads to a corresponding increase in their respective prices.
- ◆ The scale of the proposed technology provides potential and opportunities for large-scale employment creation in the Small to Medium scale Enterprises sector.
- ◆ The use of industrial and mine wastes as substrate material should lead to significantly lower manufacturing costs and correspondingly to more affordable roofing products.

The use of industrial wastes will also play a significant role in reducing the huge stockpiles of such waste and thus impact positively in cleaning up the environment.

CURRENTLY AVAILABLE APPROPRIATE TECHNOLOGIES FOR HOUSING AND BUILDING MATERIALS IN EAST AFRICA

Lugano Wilson

The East African region that includes the countries of Kenya, Uganda, Tanzania and Zimbabwe is rich in natural occurring materials that can be appropriately used to manufacture affordable building materials. While rain forests and savanna wood/grasslands cover a bigger portion of the region, the country of Zimbabwe is additionally having a bigger deposit of coal whose combustion byproducts can be utilized in the production of building materials.

Natural resins or cement can be used to bind the available natural materials and fibres to produce composites for application in the building industry.

This paper describes the currently available technologies in the region for realizing building materials using natural resins (Cashew Nut Shell Liquid), wood and wood byproducts, sisal fibres and coal combustion byproducts. Renowned research effort in supporting this industry is also described. Furthermore, problems in carrying biocomposite research and in commercialization of research outputs are discussed. The paper ends by suggesting measures to be taken in order to promote the production of natural composites in the region.

UTILIZATION OF BLACK COTTON SOILS FOR LOW COST HOUSING IN TANZANIA

Dr. Ambroce A. Shirima

In Tanzania black cotton soils are found extensively on Lake Victoria basin and along valleys of Rufiji, Kilombero and Kagera rivers. Where they occur and cover areas which are for large that avoiding or by passing then is not feasible.

The paper starts by looking at the merits and demerits of black cotton soil as a building material. It observes that the main disadvantages of black cotton soils are their low strength and their tendency to swell and expand as they absorb water.

Various possibilities of improving the engineering properties of such soils are introduced. Results of laboratory investigations carried on black cotton soils with various percentages of lime are included. The laboratory investigations indicated that 5% lime improved the engineering properties of the soil considerably.

WOOD PRODUCTS: PLYWOOD/CHIPBOARD USING DIFFERENT ADHESIVES

N.A. Kumar

Urea formaldehyde resin is widely used in most of the plywood manufacturers. The main problem encountered in this resin is the emission of free formaldehyde.

With the support of appropriate Technology, the Emission could be controlled. Although U.F Resin is used for interior purposes still it is highly preferred as it ensures quality products with less reject. At present all raw materials required to manufacture U.F Resin are met by imports.

As Resin plays a vital role in cost of production of Plywood and Chipboard, we have started to manufacture our own U.F Resin using Paraformaldehyde with Urea. This has facilitated to meet the high competition of end products in the market. This is achieved by manufacturing U.F Resin as and when required by the consumer. Therefore there is no question of shelf life of ready resin. Control budget for inventory and stock. Requirement of quality resin are controlled by changing the parameters in the process, Low infrastructure etc

Production was tried using tannin extract liquid and powder with the help of East African Tannin Extracting Company, Eldoret Kenya and found no comparison against U.F Resin. This is mainly because of high extraction cost, poor quality end products and cumbersome to use. This is applicable for both plywood as well as particle board (chipboard).

From sugar industries available molasses were mixed with U.F resin in order to reduce the high cost of U.F Resin. During this trial, it was found that the end products had good bonding strength and very dark appearance (not suitable to customers). Also the difficulty experienced in process is pre-drying of resin and

uncontrolled parameters, Emission of dust (not suitable for the environment). Therefore continuous running of production was not possible.

As described in the above first item, this product is highly recommended in our experiences.

BIOCOMPOSITES RESEARCH AND DEVELOPMENT: TIRDO EXPERIENCE

D. Makundi and R Nindie

TIRDO establishment act gives the Organization the mandate, among other things, to develop technologies that are adaptable to local industries, utilizing indigenous capacity in inputs such as raw materials, manpower and development facilities. Research and development of industrial processes utilizing locally available raw materials has been an area of particular interest.

Since its establishment, TIRDO has researched with many inputs. In most of them, promising laboratory results were obtained; a few went to pilot plant stage. One such R&D has been development of a wood adhesive utilizing locally obtained inputs, for replacing imported glue in production of plywood and particleboards.

The wood adhesive developed by TIRDO in co-operation with Forintek Canada Laboratories has features that have attracted other researchers, and, subsequently promising investigations have been made by researchers in using the glue as a binder for a range of materials, including coffee husks, rice husks, coconut coir, woven wicker mat-surfaced chipboards and so forth.

In this paper, the attributes of the glue, ongoing research and development work and areas for further research are highlighted. The future of biocomposite research and development at TIRDO with respect to patents and globalization is also covered.

LOW-COST HOUSING TECHNOLOGY DEVELOPMENT AND TRANSFER IN TANZANIA: A SPECIAL CASE FOR THE IPI INTERLOCKING STABILIZED SOIL BLOCK TECHNOLOGY

Emrod Elisante and Shukuru Kawambwa

Like many developing countries Tanzania is faced with housing problems caused by poverty and lack of cheap construction materials and technologies. Over 51% of the people live below the poverty line and cannot afford both local and imported building materials. It is estimated that the current annual demand for housing is 800,000 units but the supply is below 20%. In order to remedy this situation a handful of local R&D Institutions have conducted research on the synthesis of locally available raw materials like clay, lime, gypsum, sisal-waste, and bio-composite matrix for use in various building applications. Due to these research initiatives a significant amount of data and reports have been generated on the suitability of locally available construction materials. However the main problem currently is the lack of application of the research results apparently due to a weak industry and inability the R&D Institutions to develop their package beyond research level for subsequent transfer to industry. This paper details the experience of the Institute of Production Innovation (IPI) in technology development and transfer of low-cost housing technologies in Tanzania. A special reference is made on R&D issues pertaining to the

interlocking stabilized soil brick (ISSB) technology due to its cost-effective potential of providing decent shelter to the middle and lower strata of the society. It is shown that besides having comparable engineering performance to conventional walling materials, the ISSB has 24% cost savings over the regular sand/cement brick; consumes 93.4% less energy and pollutes 87.3% less CO₂ than conventional burnt bricks.

EVALUATION OF TREATED WOOD AND TANNIN/CNSL PARTICLE BOARDS AGAINST TERMITE DAMAGE

Dr. Asifa P. Nanyaro, Dr. B. Uronu and Mr. B.A. Mwingira

Wood service life as well as that of particle boards is shortened by deteriorating agencies which include termites, wood boring insects and decaying fungi. Timber and the particle boards are construction materials and in Tanzania they are used in telephone poles, electrical poles, fencing, bridge and house construction just to mention a few. The termites cause most of the internal damage of these products when contrasted to fungi which does some external damage. At this time of awareness of environmental conservation, timber and related resources are too scarce and valuable to allow their depletion by termites without preservation. On the other side, the desirable preservatives and wood adhesives are those ones that are environmentally friendly.

Studies on the impact of chemical residue activity against termite damage was undertaken in Sanya Plains of Kilimanjaro, Kikatiti and Njiro of Arusha Municipality in northern Tanzania. Wood pieces including those chemically treated by tannin and cashewnut shell liquid (CNSL), particle board pieces, wood (*pinus patula* species (Msindano)) rectangular blocks treated by boiling in 100% CNSL and Copper Chloride solution and long wood (*pinus patula* species) pieces, boiled in CNSL, were used. The wood pieces were randomly spread on areas with high subterranean termite incidences and assessed after 28 and 56 days of the trials. Promising preservations were recorded in treatments with combinations of tannin and copper chloride, Copper Chrome Arsenate (CCA), 40% or 100% CNSL and those using combination of CNSL and copper chloride. There was least damage in particleboard pieces and in the long pieces. It is possible that high chemical retention with least leaching was within these samples. Dimethyl Sulfoxide (DMSO) treated wood had poor performance. Treating wood before construction is economically important. Hence the need to look for appropriate preservative.

QUALITY MANAGEMENT IN PRODUCTION OF CONSTRUCTION MATERIALS; INDUSTRIAL EXPERIENCE

John T. Mallya

Through human history the environment and our needs have been changing, always requiring new ways and new materials in order to cope with those changes. This trend necessitates development of technologies and methods of production that in turn has put a challenge on management approaches resulting into better quality of products and services. It is important to apply our human resources in solving pressing needs in the field of housing for the ever increasing human population.

CONTRIBUTION OF TANZANIA'S CASHEWNUT INDUSTRY

Edwin Phillipa Dyauli

Cashewnut trees were introduced in the eastern coast of Africa by early Portuguese traders and sailors. The crop is mainly grown in Southern Tanzania, Tanga, Coast, Dar es Salaam regions and small quantities from Kyela, Ludewa and Iringa predominantly by peasant farmers.

Encouraged by the bumper cashewnut harvest in late 1960s and early 1970s which reached 145,000 tons, the Government embarked on a program through a World Bank loan to contract processing facilities scattered over the whole of cashewnut growing belt. Unexpectedly the production of raw cashewnuts fell dramatically from 1974/75 season to 16,552 tons in 1986/87. This decline in production brought about loss of revenue to farmers, processing factories, the Government and loss of employment to thousands of our youth.

EFFECTS OF SAWDUST ADDITIVES ON PROPERTIES OF NATURAL ADHESIVE BONDED RICE HUSK BOARDS

B Ndazi, J V Tesha and E T N Bisanda

Most tropical countries are endowed with vast amounts of agricultural and forestry wastes, which have not been put to any economical use. The lack of appropriate and affordable resins and hence absence of appropriate indigenous technologies are some of the major obstacles hindering the development and processing of these materials into commercial particleboards and composites.

A recent study was done to determine the effectiveness of a natural resin composed of wattle extract and cashew nut shell liquid (CNSL) for binding rice husk particleboard. Rice husk and sawdust at volume fractions ranging from 0.98 down to 0.95 was mixed with Tannin-CNSL based resin and consolidated into particleboards at a pressure of 3.4MPa and temperature of 170°C.

Composites produced were subjected to flexural bending test, water absorption and thickness swelling tests. Results show significant improvements of the modulus of rupture (MOR), and modulus of elasticity (MOE). The observed overall improvement in MOR is about 24 % and that of MOE is about 18.9%. Similarly, boards with sawdust showed less water absorption and thickness swelling.

It is concluded that while sawdust acts as filler additive, results into a better compaction and reduces spring-back of the pressed particleboard. This enhanced compactness, and improved bond strength and rigidity of the particleboard, as revealed from the SEM analyses of fractured surfaces. These then gave rise to an improved stiffness and dimensional stability of the particleboard.

PLANT FIBRE-PLANT RESIN COMPOSITES

E T N Bisanda

The unpredictable price changes in petroleum products, have made the use of synthetic resins as matrix in plant fibre reinforced composites even less attractive. Most plant fibre reinforced composites are used for substituting wood and related materials in applications where load and stress requirements are low, and where fluctuations in moisture and temperature can be tolerated. The high cost of synthetic resins would not justify their use in such applications. Recent work in Tanzania, has shown that tannin and cashew nut shell liquid, are plant based resin materials with great potential to replace synthetic resins in bio-composite manufacture. These resins have been noted to improve resistance to micro-organism and insect attack while at the same time, give better dimensional stability than some common synthetic resins. With the significant amount of plant fibre and agro-wastes available in Africa, these resins offer the best opportunity for composite development in Africa.

Annex 4: Résumés

Prof. Elifas T.N. Bisanda

Job Title: Associate Professor: Engineering

Educational Background

June, 1991 Bath, U.K. - Ph.D. in Composite Materials (Materials Science):
 June 1984 Cranfield, Bedford, U.K. - M.Sc. in Metallurgical Engineering (Materials).
 August, 1981 Dar es Salaam, Tanzania. - B.Sc. in Mechanical Engineering (Eng.).

Certifications

- Certificate as Trainer of Partnership Proposal Development and Negotiation Skills, Kampala, March 1998
- Certificate in NDT of Concrete, TIRDO, Dar es Salaam, Tanzania, Jan 1998
- Certified Trainer and Examiner of NDT Personnel, Nov. 1997, SAIW, Johannesburg, SA
- Certificate in Practical Radiography, June 1986, SANDT, Cambridge, U.K.
- Certificate in Penetrant and Magnetic Particle Inspection, May 1986, SANDT, Cambridge, U.K.

Current Activities

Associate Professor of Mechanical Engineering, University of Namibia. Teaching of Undergraduate students, management development of new programmes in engineering.

Work Experience

May 2000 – present, University of Namibia, Windhoek, Namibia

Associate Professor, Engineering. Teaching of undergraduate course, curriculum development. Supervision of engineering and technology department development plans. Research on low cost housing in Namibia.

July. 1997 to April 2000, University of Dar es Salaam.

Associate Professor: Teaching of Undergraduate courses in Materials Technology. Supervision of Postgraduate research, Coordination of SIDA funded project on Biocomposites, Coordination of the International Centre for Science and High Technology (ICS) programmes in plant fibre reinforced composites and waste minimization.

July 1994-June 1997: University of Dar Es Salaam, Tanzania.

Associate Dean, Senior Lecturer; Planning, coordination and supervision of Research, Publications and Postgraduate activities in the Faculty of Engineering, Teaching of undergraduate and postgraduate courses, Consultancy activities in NDT and Failure analysis.

Oct. 1991-June 1994: University of Dar Es Salaam, Tanzania.

Chief Editor, Senior Lecturer, Teaching of undergraduate and postgraduate courses in Materials technology, Editing the Uhandisi Journal and other Faculty Publications, Consultancy activities in NDT and Failure analysis, Coordination of Research activities in the Department of Mechanical Engineering.

March 1991-Sept. 1991: The Biocomposite Centre, Bangor, North Wales, U.K.

Visiting Research Fellow, Testing of biocomposite materials, Design and manufacture of moulds and patterns, Pulping of agricultural wastes.

Oct. 1987 - Feb 1991: The University of Bath, Avon, U.K.

Ph.D. Research Student. Doctoral research in composite materials and demonstration of practicals in Materials Science to undergraduate students.

Oct. 1984 - Sept 1987: University of Dar Es Salaam, Tanzania.

Lecturer, Teaching of undergraduate courses in Materials Technology, Consultancy activities for local firms in materials testing, failure analysis and NDT

Sept. 1983- Sept. 1984: ICI Research Centre, Billingham, Teeside, U.K.

Engineer Trainee; NDT on petrochemical plant pipelines; Corrosion testing; Metallography and Failure analysis.

Topics of Interest

- Utilisation of agricultural wastes for making composite building materials
- Production of polymers from agricultural wastes
- Building materials and low cost housing
- Recycling of plastic waste

W. O. Ogola

Educational Background: MSc. BSc (University of Manchester Institute of Science and Technology)

Institution: Egerton University, P.O Box 536 Njoro, Kenya

Current Position: Lecturer

Working experience:

ten years with the University

ten years with the Mombasa Polytechnic

three years with Industry.

Research area of interest:

Mechanical Engineering- Composites from natural fibres and natural adhesives.

W. Balu-Tabaaro

BSC Mining Engineering (Specialist Mineral Dressing Option)

Working Experience:

1976-1977	Assistant Mill Manager, Val Dor Mines, Quebec
1976-1977	Kaolin Plant Engineer - Stamico, Pugu, Tanzania
1978-1978	Plant Metallurgic, Buckreef Gold Mines Geita Mwanza
1978-1979	Assistant Mines Manager, Wazo Hill, Dar es Salaam
1979 to date	Principal Mineral Dressing Engineer, Geological Survey and Mines Dept.

Research and Development work

Research and development of alternative cements based on pozzolans (IDRC Project: 1989-1993)

Research and development of a pozzolan as a stabilizer in road construction: 1998 to date
Lime use in building blocks, stabilization: 1989-1983

Composite cements made from, OPC pozzolans for use at Owen Falls Dam, Jinja, Uganda.

Use of local mineral resources in the production of refractory products: 1990-1995

Standardization and specifications of local raw materials for building construction: 1990-1993

Using blended cements as concrete in construction -1991-1993

Investigating the durability of pozzolanic cements as facade elements in low-cost housing: 1993-1995

Investigations of structural properties of components built with pozzolanic cements: 1994

Building up a database on local raw materials for use in composites for low cost housing - 200 for Uganda National Council for Science and Technology.

Ferri Ugo, Dr. Eng.

Role Within the Company: **General Manager**

Company Group Made of:

- **VEM S.p.A.**, a company specialized in the design and construction of plants for the production of composite products and research activity on the manufacturing process
- **CIMTECLAB s.r.l.**, a company specialized in research and development activities in the field of composite products

Educational Background

University degree in Nuclear Engineering received at Bologna University in 1969.

Work Experience:

From 1969 to 1979: General Manager on site (Iraq, Nigeria) in plants for electrical distribution. From 1986 to 1996: General Manager of Vetroresina S.p.A. and then R&D Manager for Gruppo Sarplast, specialized in the production of GRP pipes and tanks, supervising the following:

- Development and selling of plants and technologies for the manufacturing of composites developed by the company (n.15 plants sold all over the world)
- Technical and technological research and development activities in the field of GRP products and process taking advantage, where possible, of financial aids from local, national and EC programs by applying both technological innovation and environmental safeguard.
- Management of n.3 R&D projects within the Brite Euram II and III programs promoted by the European Community, for the development of reinforced polymeric matrices for high pressure pipes, submerged and offshore piping, fire resistant piping.

From 1997: General Manager of VEM S.p.A. and CIMTECLAB s.r.l., the first one being specialized in design and construction of turn-key plants for the production of Glass Reinforced Polymer (GRP) composites and R&D on production process, the other one carrying out R&D activities on innovative products through its own laboratories in Trieste and Lecce strictly in cooperation with VEM and other local institutions and Universities.

Current Activities

Management and supervision of research and development activities on the following projects:

- Fiber reinforced composite pipe made of resins and fibers on natural origin, being renewable, recyclable and available
- (GRP) pipe with liner made of fluoropolymer suitable for the transportation of very corrosive fluids
- GRP pipe with liner suitable for the transportation of methane gas
- GRP pipe suitable for the transportation of natural gas at cryogenic temperatures
- GRP flexible and spoolable pipe suitable for offshore application at very high pressure conditions

Joseph Kabucho Githiomi

M.Sc. (Forest Science)

Current Activities.

Centre Director Forest Products Resource Centre.

Planning and implementing research projects.

Coordinate research and development activities within the Centre.

Management of resources (human, financial, equipment and other facilities at the Centre.
Provide leadership in dissemination of research findings and technology transfer.
Carry out day to day coordination of research and management issues between KEFRI and Forest Department.

Working Experience:

July 1986	Appointed as Assistant research Officer in Forest Products Research Programme within Kenya Forestry Research Institute
July 1990	Appointed Research Officer II
Apr. 1992 - June 1993	Acted as Head of Forest Products Research Programme
1993-1995	Taught Moi University Wood Science Department as part time lecture
1995-1998	Appointed as Forest Department/Kenya Forestry Research Institute Forest Research and Management Liaison Officer
July 1994	Appointed Research Officer I
September 1998	Appointed Senior Research Officer with the mandate of Planning and Implementing research projects.
January 1990	Appointed as a Centre Director of Karura Forest Products Resource Centre

Prof. Yusto Kaahwa

Educational Background:

Primary and Secondary Education, 1953 – 1966
University Education, B.Sc. (1970, Makerere University College, Univ. of E. Africa), M.Sc. (1973)
University of Alberta, Ph. D. in Physics (1979, University of New south Wales).

Current Position:

Professor of Physics since 1996

Working Experience:

University teaching since Aug. 1973, both Undergraduate and postgraduate courses.
Supervision of M.Sc. and Ph.D. students
Research in *Metallic Thin Films, Polymer Thin Films, Micas, Local Clays.*
Head of Department of Physics 1993 - 1997.
External Examiner in Physics in some Universities in the Region.
Associate Scientist, ICTP Trieste, Italy 1993 – 1999
Visiting Scientist, Tokyo Institute of Technology, 6 months, 1986.

Research Interests:

- Electrical Properties of Polymer Materials,
 - Characterisation of Local Clays,
 - Electronics and Instrumentation, Science and Technical Education.
- (Group Leader of Materials Science Research Group and also Group Leader of Electronics and Instrumentation Research Group in the Department)

James Minchah Onchieku

Academic Qualifications:

1998 - 1999: MSc in Biocomposite Technology, School of Agricultural and Forest Sciences, University of North Wales, UK.
1986 - 1989: Bsc in Wood Science and Technology, Faculty of Forestry and Wildlife Management, Moi University, Kenya.
1983 - 1984: Advanced Level Certificate in Mathematics, Chemistry and Biology, Homa Bay High School, Kenya.

1979 - 1982: Ordinary Level Certificate, Homa Bay Secondary School, Kenya.

Fields Of Competence:

Physical and Mechanical properties of wood and Wood-based Materials
 Fundamental Science of wood, i.e. Wood Anatomy
 Wood Preservation and Treatment

Working Experience

1998 to present: Appointed Research Officer I

Successfully undertaken an MSc degree in Biocomposite Technology
 Co-authored three (3) papers which are under consideration by publishers
 Participated in a Stakeholders Conference on "Diversification and Intensification of On-Farm Forestry for Efficient and Maximum utilisation".

1993 to 1997: Appointed Research Officer II

Project Counterpart in "Efficient Utilisation of Plantation Grown Kenyan Timbers"
 Carried out Consultancy work for East African Tannin and Extracts Company
 Technical Committee member of Wood and Wood Products of the Kenya Bureau of Standards

Helped create an inter-ministerial Timber grading, Training and Promotion course for Kenyan wood industry, engineering companies and government institutions

1989 to 1992: Appointed Assistant Research Officer

Undertook a national industrial training course
 Carried out a national timber grading survey

4.2 Responsibilities

Acting Centre Director, Forest Products Research Centre in the absence of Director
 Co-ordination of Industrial Visits and Attachment of University students
 Wood and Wood-based Working Group Leader.

Lugano Wilson

EDUCATION:	M.Sc. (Eng., Dar-es-Salaam): 1995-1997 B.Sc. (Eng., Dar-es-Salaam): 1987-1992
PRESENT POSITION:	Research and Development Engineer
CURRENT ACTIVITIES:	Undertaking studies on Biocomposite Materials for Structural Applications in collaboration with the University of Dar es Salaam. The studies cover areas of development of composite and testing of the same Under Tanzania's Commission for Science and Technology (ZERI Initiative), leading a project on appropriate houses for mushroom production in Tanzania ICS-UNIDO National Consultant for the east African region activities on the development of natural polymers and composite materials
OTHER ACTIVITES:	Carried out various assignments on materials technology such as quality assurance of thermit welds, certification of materials for use in essential oil processes, application of gypsum for industrial use such as making of insulation materials Carried out basic material technologies such as properties of metals and non-metals; physical testing of materials: impact testing, hardness testing, tensile and bending testing. Also learnt of non-destructive methods such as radiographic, ultrasonic, liquid penetrant, magnetic particle eddy current.

Research Fellow (New Materials) at ICS-UNIDO, Trieste, Italy

Industrial Consultancy

Energy Auditing

N. A. Kumar

EDUCATION QUALIFICATION:

Bachelor of mechanical engineering. Graduate from The S.J. College of Engineering Mysore. India.

EXPERIENCE:

- i) Six years in bison system particle board plant (1975 – 1981)
- ii) 1982 January onwards – working with Raiplywoods as; production engineer in particleboard and plywood plant.
- iii) 1990 to date – working as technical manager.

JOB RESPONSIBILITIES:

- A1) Project; - Selection of machineries
- A2) Expansion activities of the organisation
- A3) Technical advice on maintenance of quality control plywood, particle board, blockboard, thermo oil boilers, U.F resin
- A4) Selection, training and development of staff
- A5) Process control in particleboard, plywood, and slice veneer, laminated boards.

Makundi, Daniel

Date of birth: 30th MARCH, 1960

NATIONALITY: TANZANIAN

EDUCATION:

B.Sc.(Hons) Mechanical Engineering, University of Dar es Salaam, 1986.
M.Sc. Production Engineering, Ahmadu Bello University Nigeria, 1990.

PRESENT POSITION: Senior Research Officer II with Tanzania Industrial Research and Development Organization (TIRDO) since 1996.

POSTS HELD:

1993 - Research officer I with TIRDO
1989 - Research Officer II with TIRDO
1986 - Research Officer III with TIRDO

EXPERIENCE:

- ◆ production engineering and management including maintenance
- ◆ design and development of process equipment
- ◆ industrial surveys and technical audits
- ◆ trainer in information technology
- ◆ university undergraduate lecturer in engineering mechanics and project management
- ◆ networking and system management, including programming and web page authoring.

MEMBERSHIP TO PROFESSIONAL BODIES:

Member, Institution of Engineers Tanzania (IET)
 Member, Network of Users of Scientific Equipment In Southern Africa
 (NUSESA)
 Registered Engineer (Mech.) Engrs. Reg. Board, TZ.

LANGUAGES:

English, Kiswahili

Nindie, Robert

Date of birth: 6th SEPTEMBER 1956

NATIONALITY: TANZANIAN

EDUCATION:

B.Sc. (Mechanical Engineering), University of Dar es Salaam
 M.Sc. (Advanced Manufacturing Systems) University of Nottingham, 1988

PRESENT POSITION: Principal Research and Development Officer,
 Engineering Department at
 the Tanzania Industrial Research and Development Organization (TIRDO).

POSTS HELD:

Research & Development Officer

EXPERIENCE:

Design of a gassifier
 energy audits and management
 industrial surveys and data collection
 technical audits

LANGUAGES:

English, Kiswahili

John T. Mallya

EMPLOYMENT AND BUSINESS HISTORY

1978 to date	M/S Apex Int. Ltd. - Dar es Salaam <i>Managing Director</i>
1993 to date	M/S WOOD-PLUS Ltd. - Dar Es Salaam <i>Managing Director</i>
1979 to 1992	<i>Iwata Kiito Co Ltd</i> <i>Country representative</i>
1975 -1978	M/S Spares and Accessories Ltd. <i>Shop Manager</i>

OTHER BUSINESS INTERESTS

Shareholder – CRDB Bank Ltd

Founder member & Shareholder–Akiba Commercial Bank Ltd

TRAINING

1974 -1975 Korogwe Teacher Training College - Tanga
Grade "A" Teaching program
Member of the College Basketball and Handball team

Jan1974 - July1974 National Service Training - Oljoro, Arusha
Best Trainee

EDUCATION

1973 - 1974 Ruiru High School - Kenya

1969 - 1972 Mawenzi secondary School - Kilimanjaro

1965 - 1967 Middle School – Lyamungo - Kilimanjaro

SHORT COURSES / WORKSHOPS / SEMINARS

1998 Business Management – Dar es Salaam.

10/08/98 to 07/09/98 Microcomputer Application – DSM University

30/09/96 to 04/10/96 “ SME's Development in the EU-SADC
Context” - Rome & Naples, Italy

MEMBERSHIP & VOLUNTEER SERVICE

1996 to date *Rotarian (Paul Harris Fellow) - Rotary Club of Dar es Salaam*
North

Board member–SIDO Dar-es-Salaam Regional

Member – “Mshikamano wa Kujiendeleza” group

LEISURE:

1987 to date *Member - Gymkhana Sports Club (Tennis)*

Prof. P.V. Kandachar

Position within the Institution

Associate Professor

Educational Background

Born (1946), grown up and educated in India. Graduated as Bachelor of Engineering (Mechanical Engineering) in 1966 and as Master of Engineering (Mechanical Engineering, specialization: Applied Metallurgy and Materials) in 1968. Carried out research in the same field at the Indian Institute of Science, Bangalore, India, till 1974, leading to the award of the Ph.D. degree. Worked as Research Assistant at the same time.

Moved over to the Delft University of Technology (Department of Materials Technology), The Netherlands, in 1974 and carried out research in the field of applied

materials technology. Accepted a position at the Fokker Aircraft in 1980, a reputed aircraft designer and manufacturer in The Netherlands. Till 1995, fulfilled various management positions, among others as head of the Department of Materials and Manufacturing technology, which was responsible for R&D in the areas of Metals, Composites, Adhesives, Component Design, Manufacture & Inspection Technologies. The personal tasks included contribution to company policy Development & execution; managing 60 to 100 academic specialists conducting scientific and applied research; bridging the link between marketing, research, design & production; international co-operation in the field (Europe, USA).

Current Activities

In 1995, moved back to Delft University of Technology, The Netherlands, Faculty of Industrial Design Engineering, as Associate Professor, Educating design-engineering students and graduates in the areas of Materials & Manufacturing Technology and Materials Selection during Design. Other tasks include supervising final years Masters Degree students during their graduation thesis work; Supervising Ph.D. students during their thesis work; Research policy formulation for the Faculty; Departmental management tasks.

Topics of Interest

- Exploring the possibilities of renewable materials like biopolymers to design load carrying products for consumer use.
- Exploring the possibilities of renewable materials (like biopolymers, natural fibres, biocomposites, etc.) in the design of components for lightweight and inexpensive automobile to save energy and material.
- Exploring the possibilities of waste paper in design of products meant for packaging of consumer goods.

Hamilton Sithole

Job Title

Research Engineer

Organization and Address

Scientific & Industrial Research & Development Centre,
No 1574 Alpes Road, Hatcliffe,
P.O. Box 6640,
Harare, Zimbabwe.
Tel (263) 04-860320/9
E-mail: hsithole@sirdc.icon.co.zw

Educational Background

B.Sc. Engineering Honours (Civil) - University of Zimbabwe – Zimbabwe
M.Sc Engineering (Structures) - University of the Witwatersrand - South Africa

Current Activities

Remedial workshop on old factory building with a view of preserving its unique architectural features.

Topics of Interest

Research on mining waste material with a view of converting into environmental friendly building materials

NANYARO, ASIFA PETRO

Date of birth: 21 March 1952

NATIONALITY: TANZANIAN

MARITAL STATUS: Married

EDUCATION:

1976: BAsc Engineering Science, Aerospace Option, University of Toronto, Canada majoring in Aerospace and Astronautics with minor in Philosophy.

1978: MAsc in Aeronautics and Astronautics, University of Toronto Institute for Aerospace Studies, Canada.

1984: PhD in Aeronautics and Astronautics, University of Toronto Institute for Aerospace Studies, Canada.

IN-SERVICE TRAINING (PROFESSIONAL)

April 1973 - August 1973, Officer Cadet Training, Canadian Forces Base Borden, Canada (ROTP PROGRAMME)

April 1974 - August 1974, Platoon Commanders Course at Canadian Forces Base Chilliwack, Canada (ROTP PROGRAMME)

April 1975 - August 1975, Field Engineering Troop and Squadron Commanders course at Canadian Forces Base Chilliwack, Canada (ROTP PROGRAMME)

August 1976 - December 1976, Military Engineering Staff Officer Commanders Training at Canadian Forces Base Chilliwack, Canada, (MILE 45 ROTP 'A' PROGRAMME)

March 1990 - March 1991, Command and Staff Course at Tanzania Command and Staff College, Arusha, Tanzania.

January 1993 - Mobile International Defence Management Course, Defence Resources Management Institute, held in Harare Zimbabwe.

September - December 1995, Defence Resources Management Course, Defence Resources Management Institute, Naval Postgraduate School, Monterey, California, USA.

SERVICE BACKGROUND AND ADMINISTRATIVE EXPERIENCE

Enlisted 6 March 1972

1 April 1984 - Commissioned in the rank of Second Lieutenant and promoted to the rank of Major

1984 - 1987 - Assistant Director of Research and Development, DFHQ, Ministry of Defence and National Service, Tanzania

1987 - 1989 - Acting Director of Research and Development, DFHQ, Ministry of Defence and National Service, Tanzania

1991 - Promoted to Lieutenant Colonel

1991 to May 1996 - Director of Equipment and Maintenance, DFHQ, Ministry
of Defence and National Service, Tanzania

June 1996 to date - Director General, Tanzania Industrial Research and
Development Organization (TIRDO).

LANGUAGES: Parent (Meru), Swahili, English and French.

HOBBIES OR SPECIAL INTEREST: Sports, Reading and Outdoors.

Annex 5: The Workshop programme

MONDAY 25 – 09 – 2000		
OPENING SESSION		
0830 – 0845	Registration	
0845 – 0850	Address by Director General, TIRDO	
0850 – 0900	Address by ICS-UNIDO Consultant, Prof. Sergio Meriani	
0900 – 0910	Official Opening by the Regional Commissioner, Hon. Daniel Ole Njoolay	
0910 – 0915	Group Picture	
Coffee Break		
SESSION I: Chairman Dr. G.M. Kawiche		
1000 – 1030	Prof. E. T. Bisanda	Low-cost Housing from Natural Materials; The Case of Bamboo and Clay
1030 – 1045	Discussions	
1100 – 1130	Eng. Balu-Tabaaro	Composite Engineering Materials for the Building and Construction Industry.
1130 – 1140	Discussions	
1140 – 1210	J. K. Githiomi	Standardization of Timber and Related Composite Products in Kenya
1210 – 1220	Discussions	
1220 – 1250	Mr. N. A. Kumar	Wood Products: Plywood/Chipboard Using Different Adhesives-A Research
1250 – 1300	Discussions	
Lunch		
SESSION II: Chairman Prof. E.T.N. Bisanda		
1400 – 1430	Dr. Ugo Ferry	Functionalisation of Cardanol with Some Reactive Monomers
1430 – 1440	Discussions	
1440 – 1510	Dr. A. A. Shirima	Utilization of Black Cotton Soils for Low- cost Housing in Tanzania
1510 – 1520	Discussions	
1520 – 1550	Prof. Y. Kaahwa	Properties and Applications of Ugandan Kaolin
1550 – 1600	Discussions	
Coffee Break		
SESSION III: Chairman Prof. S. Meriani		
1630 – 1700	Engs D. Makundi and R. Nindie	Biocomposite Research and Development: TIRDO Experience
1700 – 1715	Discussions	
1715 – 1745	Dr. G. M. Kawiche	Soil Stabilization With Resinous Materials
1745 – 1800	Discussions	

TUESDAY 26 – 09 – 2000		
<i>SESSION IV: Chairman Dr. A.P. Nanyaro</i>		
0900 – 0930	Mr. Wilson O. Ogola	The Potential of Coffee Husks as Wood Substitute in the Production of Particleboards
0930 – 0945	Discussions	
0945 – 1015	Mr. E. P. Dyauli	Contribution of Tanzania's Cashew Industry
1015 – 1030	Discussions	
Coffee Break		
<i>SESSION V: Chairman Prof. Y. Kaahwa</i>		
1100 – 1130	J. M. Onchieku	Potential Plant Fibres and Plant Resins for the Manufacture of Low-cost Housing Materials in Kenya; an Overview.
1130 – 1140	Discussions	
1140 – 1210	Mr. B. Ndazi	Saw Dust additive on Natural Resin Bonded Rice Husks
1210 – 1220	Discussions	
1220 – 1250	Mr. J. Mallya	Talking points: Building Materials; Industrial Experience
1250 – 1300	Discussions	
Lunch		
<i>SESSION VI: Chairman Prof. S. Meriani</i>		
1400 – 1445	Prof. E.T.N. Bisanda	Plant Fibre – Plant Resin Composites
1445 – 1500	Discussions	
1500 – 1545	Col. Dr. A. P. Nanyaro	Evaluation of Treated Wood and Tannin/CNSL Particleboard Against Termite Damage
1545 – 1600	Discussions	
Coffee Break		
1630 – 1800	Industrial Visit	

WEDNESDAY 27 – 09 – 2000		
SESSION VII: Chairman Dr. Kawiche		
0900 – 0930	Mr. Hamilton Sithole	Industrial Production of Roofing Materials Using Low-cost Hybrid Materials
0930 – 0945	Discussions	
0945 – 1015	Mr. L. Wilson	Currently Available Appropriate Technologies for Housing and Building Materials in East Africa
1015 – 1030	Discussions	
Coffee Break		
SESSION VIII: Chairman Prof. Y. Kaahwa		
1100 – 1130	Prof. P. V. Kandachar	Design With Natural Fibre Composites
1130 – 1145	Discussions	
1145 - 1215	Dr. E. Elisante	Low-Cost Housing Technology Development and Transfer in Tanzania: A Special Case for the IPI Interlocking Stabilized Soil Block (ISSB) Technology
1215 – 1230	Discussions	
1230 – 1250	Dr. Bashir O. Ahmed	Project Proposals and Investments in the European Union
1250 – 1300	Discussions	
Lunch		
SESSION IX: Chairman Prof. E.T.N. Bisanda		
1400 – 1430	Workshop observations, recommendations and project proposals.	
CLOSING SESSION		
1500 – 1510	Address by Director General-TIRDO	
1510 – 1520	Address by ICS-UNIDO Consultant, Prof. S. Meriani	
1520 – 1540	Official closing by UNIDO Resident Representative in Tanzania, Mr. F. Ugbor	
1540 – 1600	Group Picture	

Annex 6: Evaluation questionnaire

A. Organization:

1. How did you obtain information about this workshop/course?

	Excellent	Very Good	Good	Fair
2. The information process was	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. The announcement and pre-course material was	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• Describe the content of the workshop/course:				

4.1 I found the scientific programme	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.2 Applied Lecture/Workshop	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.3 Use of small working groups	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.4 Case Studies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.5 The time spent by lecturers in class and after class on specific questions/examples	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.6 Students scientific knowledge was	Balanced <input type="checkbox"/>	Unbalanced <input type="checkbox"/>		

B. Duration of programme:

	Just right	Too long	Too short
1. Number of days	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Length of working days	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

C. Training facilities & Hotel:

	Excellent	Very Good	Good	Fair
1. Lecture/Training Rooms	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Breaks/refreshments	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Hotel accommodation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Meals at the hotel	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
If "Fair" please explain why: _____				

D. Organizer's response to needs	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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E. Overall programme organization	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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F. Would you recommend to others from your institution/country to attend a similar activity in the future?

Yes	Maybe	No
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

G. Program evaluation

1. Which part of the Activity did you find most useful?

2. Which part of the activity do you think should be expanded?

3. Which part of the activity do you think should be dropped?

4. Any other suggestions for future improvements to the programme?

5. Do you think that the topics/tools you studied during the course could be used by industries in you country? If so, how? If not, why not?

6. Can you suggest any programme and future activities which ICS could pursue in order to help with the technological and scientific advancement of your country?

7. Do you think you have benefited from participation in this course/workshop? If so, how? and your Institution?

8. How do you intend to disseminate the information you have acquired during the activity once back in your own country?

H. Evaluation of Lectures and Speakers

	Excellent	Very Good	Good	Fair
1. Course material	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Resident Lecture presentation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. International Lecture presentation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Ability of lecturers to answer specific questions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Any comments:

Thank you for your collaboration

September, 2000

Annex 7: Evaluation summary

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Totals	Ave							
A 1	O	T	T	T	T	T	T	K2	L2	I	I	T	T	T	S2	D	I	T	6	I	3	D	1	O	4		
2	E	V	G	E	E	G	V	V	V	E	E	E	G	V	E	V	E	E	10	V	6	G	3	F	0	V	
3	V	E4	G	E	E	G	V	V	V	E	V	E	G	V	E	G	E	E	5	V	5	G	6	F	0	V	
4	4.1	V	E5	V	V	V	V	V	E	V	E	E	G	V	E	G	E	G	6	V	6	G	3	F	0	V	
4.2	V	V	V	V	V	G	G	V	V	V	E	E	V	E	V	E	V	E	4	V	11	G	2	F	0	V	
4.3	G			V	V	G				V		E		G	G			E	1	V	3	G	3	F	0	V	
4.4	G			V	V	V		V	V	V	V	V		G	V	G	E	G	1	V	9	G	4	F	0	V	
4.5	V		V	G	V	G		V	V	V	E	E		E	G	E	G	E	4	V	5	G	4	F	0	V	
4.6		B		B	B	B		B		B	B	B		B	B	B	B	B	13	U	0					B	
B 1	S	R	R	S	S	R	R	R	R	R	R	R	R	R	R	R	R	R	4	R	14	L	0			R	
2	R	R	R	S	S	R	R	R	R	R	R	R	R	R	L	R	L	R	S	1	R	15	L	2		R	
C 1	V	V	E	V	E	G	V	V	V	E	E	E	G	G	V	V	E	V	E	6	V	9	G	3	F	0	V
2	V	V	E	V	E	G	E	V	V	E	E	E	G	G	E	E	E	V	E	9	V	6	G	3	F	0	V
3	V	V	E	V	E	G	V	V	V	E	E	E	G	G	E	E	E	V	E	9	V	5	G	3	F	0	V
4	V	V	E	V	E	G	V	V	E	E	E	V	G	G	E	V	E	G	E	7	V	7	G	4	F	0	V
D 1	G	V	E	E	E	G	V	E	V	E	E	E		V	E	V	E	E	10	V	5	G	2	F	0	V	
E 1	V	V	E	V	E	F	E	E	V	E	E	E		V	E	V	E	E	10	V	6	G	0	F	1	V	
F 1	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	18	N	0				Y	
G 1	D22	E22	F22	G22	H22	I22	J22	K22	L22	M22	N22	O22	P22	Q22	R22	S22	T22	U22									
2	D23	F23	G23	H23	I23	K23	L23					O23	P23	Q23	R23	S23	T23	U23									
3																											
4	D23	F25	G25	H25	I25	J25	K25	L25	M25	N25	O25	P25	Q25	R25	S25	T25	U25										
5	D24	F26	G26	H26	I26	J26	K26	L26	M26	N26	O26	P26	Q26	R26	S26	T26	U26										
6	D25	E27	G27	H27	I27	J27	K27	L27	M27	N27	O27	P27	Q27	R27	S27	T27	U27										
7	D26	E28	F28	G28	H28	I28	J28	K28	L28	M28	N28	O28	P28	Q28	R28	S28	T28	U28									
8	E29	F29	G29	H29	I29	J29	K29	L29	M29	N29	O29	P29	Q29	R29	S29	T29	U29										
H 1	G	V	V	G	V	V	V	E	V	V	E	E	V	V	E	V	G	E	E	5	V	9	G	3	F	0	V
2	G	G	V	V	V	G	V	V	V	V	E	E	V	V	E	V		E	E	4	V	10	G	3	F	0	V
3	V	V	E	V	V	G	V	V	V	E	E	E	G	V	E	V		E	E	6	V	9	G	2	F	0	V
4	V	G	E	V	V	G	V	V	V	V	E	E	V	V	E	G		E	E	5	V	9	G	3	F	0	V
I 1	E32	F32	G32	H32	I32	J32	K32	L32	M32	N32	O32	P32	Q32	R32	S32	T32	U32										

Key to abbreviations:

B	Balanced	O	Other institution
D	UNIDO	R	Just right
E	Excellent	S	Too short
F	Fair	T	TIRDO
G	Good	U	Unbalanced
I	ICS	V	Very good
L	Too long	Y	Yes
N	No		

Note: Italicized cell entries are identifiers for the comments associated with those cells.

The cells with data/information range from spreadsheet cell D2 (ie column D, row 2) to U32 (column U row 32). The cells containing comments are indicated by a triangle at the top right corner.

Cell: D4
 Comment: KEFR!

Cell: K4
 Comment: Uganda National Commission for Science and Technology (UNCST).

Cell: L4
 Comment: Nomination by a local organization.

Cell: S4
 Comment: My colleague, Dr Chikamai [who had] attended [a previous] Trieste Workshop nominated me.

Cell: E6
 Comment: Development and designing with natural (locally available) low-cost material using affordable low-cost technologies.

Cell: I6
 Comment: Relevant to current building/housing alternative use of local material/affordable in light of government care.

Cell: J6
 Comment: The presentation and course materials was of excellent quality.

Cell: S6
 Comment: There is, in general, a lack of databases of forest-wood wastes and agricultural wastes. To be carried out.

Cell: T6
 Comment: Abstracts were provided on the [TIRDO] website.

Cell: D7
 Comment: Engineering Department:

Cell: D22
 Comment: CNSL database

Cell: E22
 Comment: Presentations and discussions

Cell: F22
 Comment: The lectures

Cell: G22
 Comment: Consideration of developing the low cost building material.

Cell: H22
 Comment: The potential of research being undertaken to yield low-cost material/inputs.

Cell: I22
 Comment: Case presentations from different participants.

Cell: J22
 Comment: Discussions after each presentation was very stimulating.

Cell: K22
 Comment: Databases and case studies.

Cell: L22
 Comment: Presentations on using local materials.

Cell: M22
 Comment: Discussion of presentations, as it allowed for more interaction and exchange of ideas.

Cell: N22
 Comment: Biocomposites research.

Cell: O22
 Comment: I found the entire conference very useful and informative.

Cell: P22
 Comment: Presentation of scientific and engineering papers.

Cell: R22
 Comment: Technical co-operation.

Cell: S22
 Comment: Use of natural resins.

Cell: T22
 Comment: Academic exchange.

Cell: U22
 Comment: Scientific and technological experiences.

Cell: D23
 Comment: CNSL

Cell: F23
 Comment: Discussion in small groups.

Cell: G23
 Comment: Development of appropriate low cost production technology.

Cell: H23
 Comment: Application of R+D results must be expedited.

Cell: I23
 Comment: Visits to sites and research institutions.

Cell: K23
 Comment: Data on testing methods - material characterization.

Cell: L23
 Comment: Visits to local industries.

Cell: O23
 Comment: Industrial visits.

Cell: P23
 Comment: More involvement of the wider scientific community.

Cell: Q23
 Comment: The Workshop should include other materials apart from composites.

Cell: R23
 Comment: Transfer of technology.

Cell: S23
 Comment: Database on natural fibres and resins.

Cell: T23
 Comment: Transfer of technology, marketing dissemination and networking.

Cell: U23
 Comment: Marketing [segmentation (?)].

Cell: D25
 Comment: Financial support from government

Cell: F25
 Comment: When dealing with housing issues, architects and structural engineers should be encouraged to take a more active role.

Cell: G25
 Comment: Let us consider the appropriateness of all this to reach the rural people who have no money.

Cell: I25
 Comment: Clear information on what presenters/participants should prepare for the programme.

Cell: J25
 Comment: Papers to be presented should be distributed beforehand. Some papers weren't. This makes for better debate.

Cell: K25
 Comment: More networking.

Cell: M25
 Comment: Exhibitions of products or specimen should be arranged and improved. These make the workshop more exciting.

Cell: O25

Comment: The ICS conferences should be rotated in the region to give participants a chance to know what those countries are designing in this area of biocomposites.

Cell: P25

Comment: 1) Limitation of multimedia presentation package be made clear to presenters before the meeting.
2) The evaluation form should be designed specifically for the workshop.

Cell: S25

Comment: Prior consultation with members on papers to be presented.

Cell: U25

Comment: Prepare common technological solutions for the country.

Cell: D26

Comment: Topics:
To improve quality
To do more research in existing material, plant and machinery

Cell: F26

Comment: Yes

Cell: G26

Comment: Yes, through dissemination process where the right stakeholders can be included.

Cell: H26

Comment: Yes, some of it is already being implemented.

Cell: I26

Comment: Yes, because there are a lot of research findings or ongoing research on local materials or within our region that need to be adopted to minimize cost but also to be adopted to our conditions.

Cell: J26

Comment: Considering the theme of the Workshop, this is very relevant to my country. If we are to improve housing, then the implementation of these findings would be very helpful.

Cell: K26

Comment: Yes. To expand range of products and make them better.

Cell: L26

Comment: Yes, by disseminating the research.

Cell: M26

Comment: Yes, most developments in low-cost building materials are ready for commercialization. Wider dissemination to the society is needed.

Cell: N26

Comment: Yes, through substitution of import of inputs with locally produced alternative.

Cell: O26

Comment: If properly disseminated, I think they will be very much willing to adopt the technology. The public/end users need to be sensitised on the new materials and their advantages.

Cell: Q26

Comment: The technologies discussed in the workshop are applicable and appropriate.

Cell: S26

Comment: Yes, roofing material are appropriate; walling/partitioning material could be adopted.

Cell: U26

Comment: Technological cooperation among the countries in order to implement common economical [solution], pilot plants etc.

Cell: D27

Comment: Steps to reduce the cost of production
Updating the existing plant machines to obtain cheaper, better quality products.

Cell: E27

Comment: Particularly those related to R+D of building material and related fields to improve the existing poor situation of housing.

Cell: G27

Comment: Ways of disseminating the technology

Cell: H27

Comment: Demonstration of technologies, e.g. tile-making machine, chipboards etc.

Cell: I27

Comment: More information and dissemination of research findings to users through a monthly or bi-annual publications and support demonstrations to users of technology found.

Cell: K27

Comment: Raw material characterization/designs.

Cell: L27

Comment: Country preparation on existing status.

Cell: M27

Comment: Establish an electronic network (egroup) through which we can continue to interact, since most participants are on email.

Cell: O27

Comment: A similar conference in my country and involving the researchers, industrialists, policy makers and possibly consumers will create some awareness.

Cell: P27

Comment: 1) Networking and linkage of materials researchers in the region.
2) Assistance with wider dissemination of information knowledge.

Cell: Q27

Comment: KEFRI should be facilitated to acquire a composite moulder and blender to facilitate further research on the composite process.

Cell: S27

Comment: Establish/carry out inventory of wood wastes/residues and agricultural wastes to have a database.

Cell: U27

Comment: Training of people in Europe on industrial technological activities.

Cell: D28

Comment: Assessing the requirements

Cell: E28

Comment: Yes, by learning on importance of generating building material from local material using affordable technology
Necessity of forming databases for references in the future R+D.

Cell: F28

Comment: As far as composite materials are concerned, it was an eye opener (for me)

Cell: G28

Comment: I have met different researchers and had an opportunity to exchange ideas now remains the coordination.

Cell: H28

Comment: Expansion of knowledge, new research direction.

Cell: I28

Comment: Yes, I learnt of things/materials that we have, but were unknown to me yet can greatly reduce cost.

Cell: J28

Comment: The sharing of ideas always make for better and improved designs.

Cell: K28

Comment: Yes, access to more helpful information.

Cell: M28

Comment: Yes, made new contacts, and heard of other innovations.

Cell: O28

Comment: Yes, very much. I have learned what latest developments there are in this area.

Cell: P28

Comment: Yes, interesting topic for investigation came up. This can be investigated in the institution.

Cell: Q28

Comment: Yes, I learnt from other participants' experience.

Cell: S28

Comment: Very much wider scope in housing materials in general and walling material in particular.

Cell: U28

Comment: Yes, as far as experience made by other organizations in [biocomposites] applications.

Cell: E29
Comment: R+D

Cell: G29
Comment: Through seminars and workshops as well as advertisement.

Cell: H29
Comment: In technical meetings, general public.

Cell: I29
Comment: Establish links with local research institutions where I can get advice and information on processes.

Cell: J29
Comment: Hold seminars for stakeholders.

Cell: K29
Comment: Hold local seminars, write reports to our institutions and prepare project proposal.

Cell: M29
Comment: Link with the institutions.. Try to encourage commercial enterprise in building technologies.

Cell: O29
Comment: I will hold seminars in my university and other available forums to sensitize them in this field if funds can allow.

Cell: P29
Comment: Report and initiate discussion on these.

Cell: Q29
Comment: Through scientific seminars within the institute and other related institutions.

Cell: S29
Comment: Present workshop proceedings in KEFRI's scientific forum.

Cell: U29
Comment: Collaborating with ICS for future activity on promoting composites using natural components.

Cell: E34
Comment: The program was good, since it brought together researchers, developers and entrepreneurs to share their experiences and views on how the living conditions of the majority can be improved.

Cell: H34
Comment: I thank UNIDO, ICS and organizers for organizing this seminar.

Cell: K34
Comment: Strengthen networking.

Cell: M34
Comment: More participation from industry should be encouraged. In this workshop, we benefited from contribution from the cashew industry. We could have learnt more from Katani Ltd, Sikh Saw Mills, Coffee Curing Ltd, sugar manufacturers etc., who could have sponsored themselves.

Cell: N34
Comment: Very well organized.

Cell: O34
Comment: More of these forums need to be initiated and possibly a regional co-operation with annual or half-yearly meetings to follow up the progress in this area. Perhaps networking will also be very necessary with new developments in communications (email etc.)

Cell: Q34
Comment: The initiative of ICS-UNIDO-TIRDO to bring the participants within the East African region together to share experiences is commendable.

Cell: S34
Comment: ICS-UNIDO to facilitate:
 1) inventory and database creation within East Africa
 2) human resource improvement through opportunities of higher learning.

Cell: U34
Comment: Preference of local entrepreneurs should be welcome in order to transfer new technologies.

Annex 8: Workshop recommendations

The following workshop observations are the result of discussions that followed after each presentation session:

Session I

- ◆ Need to introduce simple soil testing methods such as sedimentation.
- ◆ Locally produced compressing machines are cheaper than imported ones e.g. IPI manufactured machines sell around US\$ 400 and produce 450 bricks/day whereas Indian machines sell at US \$2,000 and produce 1,000-2,000 bricks/day which is more attractive to small businessmen.
- ◆ The cultural barriers can be overcome through demonstrations and exhibitions.
- ◆ Need to establish inventory of natural fibres in each country and create inter-linkages within the region.
- ◆ Cassava paste has limitation for interior uses only, Therefore efforts to use resins should be encouraged by collaboration with other institutions such as TIRDO.

Session II

- ◆ The technology on functionalisation of cardanol with some reactive monomers has been successfully applied in production of pipes but its application on wood products has not been investigated.
- ◆ Entrepreneurs should be encouraged to patent their products.
- ◆ There is a need to work for alternative raw materials to replace wood applications.
- ◆ There is a need to develop and perfect local technologies such as wood drying.

Session III

- ◆ Need to assess characteristics and behavior of black cotton soil for housing applications.
- ◆ The use of polymer to stabilize clay is an expensive alternative for housing material, efforts to develop and use cheap materials should be encouraged:
- ◆ To look into ways of involving industrialists in supporting research activities.

Session IV

- ◆ More investigation is required on ratios of resins and agro-product such as rice husks at different conditions.
- ◆ A lot of work has been done on the use of sawdust but its particle shape cannot allow to provide acceptable strength of composites.
- ◆ Economic analysis of recycling agro-wastes into building materials in many cases has not been carried out.
- ◆ The particle boards made out of CNSL ends with unfavorable colour though has good physical and mechanical properties, therefore efforts should be done to improve the image for commercialization purposes.
- ◆ Extraction of CNSL by dehumidification method leaves significant liquid in shell residue. It is therefore suggested to look for better processes or process boards from the residue.

Session V

- ◆ Encourage the use of simple technologies for extraction of tannin product.
- ◆ Techno-economic studies in the use of baggase as fuel source or biocomposite material should be encouraged prior to the use of material.
- ◆ Raiply is facing resin formulation problems that can be solved in collaboration within other institutes in the sub-region.

Session VI

- ◆ CNSL liquid can be used as wood preservative and find its application in treating wood poles.
- ◆ TIRDO can look into different methods of treating wood using CNSL.

Session VII

- ◆ It is a normal procedure to use formed shapes against rollers while giving desired corrugations to roofing materials.
- ◆ The roofing materials drying cycle could be enhanced so as to shorten the process. Use of hot plates and tannins are possible solutions.
- ◆ Materials properties could be established first so as to simulate the product quality before producing prototypes.
- ◆ Fixing mechanism of the developed roofing tiles is important against wind, etc.
- ◆ The need to establish a databank of potential materials for biocomposite development for the E.A region. The databank should include existing production units and capacities thereof.
- ◆ Networking amongst researchers, manufacturers and users of

biocomposite materials could be enhanced by establishing a regional body – "Materials Research Forum". The forum will provide a platform for information dissemination.

- ◆ Materials research in the region has to be need oriented and be directed to solve typical housing problems e.g. to replace coconut leaves thatched roofs in coastal areas by sisal composites.
- ◆ There are biocomposite production units in the region.

Session VIII

- ◆ Biocomposite products are generally more expensive than the synthetic counterparts. Policy makers have the role to increase their application through subside programs (incentives).
- ◆ The design process starts from human needs. Other important features are aesthetics, costs, strength, environmental friendliness, etc.
- ◆ When different particles are mixed in composites bonding characteristics can be improved by surface modifications.
- ◆ There is a need to establish design databases for biocomposite development in the region. The information to be included should show performance characteristics with their minimum and maximum variations.
- ◆ Since over 90% of our region's population is rural it will be for peoples' advantage to use cheap and available materials in designing machinery and tools, for example using wood against metallic materials.
- ◆ In some locations the interlocking bricks could be produced without addition of cement to the solid.
- ◆ Houses built using IPI interlocking bricks have shown comparable stability to design factors like conventional materials.

- ◆ Housing technologies can be easily disseminated through demonstration centres.
- ◆ Though the European Union's biocomposites researches are centered in Europe it is possible to apply for financing through European counterparts like ICS-UNIDO. Co-financing becomes more attractive to financiers especially when the project is regional.
- ◆ Technical staff training in the European Union gains acceptability on belief that the trained staff will catalyze the technology know how in their home countries
- ◆ For Europe to cooperate in Africa projects it is important that there should be local entrepreneurs who are willing to participate fully and who will co-finance projects.

The last workshop session was set aside for making in depth discussions that aimed at generating project proposals and making workshop recommendations. Following were the recommendations:

- 1.** The exchange of information (practice, standards, etc.) between scientists and manufacturers be enhanced. This calls for the establishment of the "Materials Research Forum". The forum needs to cover a wider region taking into consideration of the fewer materials scientists.
- 2.** To carry out a tracer study that will give an understanding of existing materials scientists in the region.
- 3.** Establishment of the building materials council for East Africa. The council will provide a platform for meeting, exhibitions, researcher exchange and cooperation. A memorandum of understanding need be signed by all institutions represented in the workshop and others could join later. This will later become a focal point to enforce implementation of resolutions as well as serve as a base in looking for resources—human, financial, and so forth
- 4.** Need for human resource development by training researchers and scientists.
- 5.** Carry out a project that will provide a database of human resource, equipment, production units and research capacity in East Africa. The database be available in hard copy and be posted on web.
- 6.** Characterization of biocomposite materials be carried out to provide properties for design purposes.

Annex 9: Opening and closing speeches/remarks

WELCOME ADDRESS BY COL. DR. ASIFA P. NANYARO DIRECTOR GENERAL TIRDO TO THE INTERNATIONAL WORKSHOP ON DEVELOPMENT OF NATURAL POLYMERS AND COMPOSITES IN EAST AFRICA

Guest of Honour, the Arusha Regional Commissioner, Hon. Daniel Ole Njoolay, Professor Sergio Meriani, the Consultant, New Materials Programme ICS UNIDO.
Distinguished Guests
Workshop participants,
Ladies and Gentlemen.

I would like to welcome the Guest of Honour, the Regional Commissioner for Arusha, Hon. Daniel Ole Njoolay and Development of natural polymers and composites in East Africa. We are most thankful to the Guest of Honour who has spared his time despite other important activities and other pressing obligations to officiate the opening of the meeting. Please feel at home in Arusha. It is my belief that the participants will take advantage of this opportunity and will exchange ideas and experiences in the field of natural polymers and composites.

Tanzania Industrial Research and Development Organization (TIRDO in Collaboration with the International center for Science and High Technology (ISC UNIDO) have organized this meeting at Impala Hotel from 25th to 27th September, 2000. The financing has been provided by United Nations Industrial and Development Organization (UNIDO and TIRDO).

We are most thankful to UNIDO.

The workshop objective is to promote research and application of natural polymers and resins in the form of composites for use in the construction industry, especially in low cost housing.

Guest of Honour, the Development of Natural Polymers and Composites in East Africa focuses mainly on basic human needs to improve human settlements in poverty ridden areas which is a common phenomena to most developing countries. In the workshop therefore the experts will share experiences

and ideas from research and development institutes, universities, industry and individuals with a focus on the following, -

- a. Applied research and commercialization of natural composites to produce cheap building materials using local materials and affordable technologies.
- b. Means of disseminating appropriate developed technologies in housing and building materials by incorporating entrepreneurs needs.
- c. Regional and South-North cooperation needs to enhance research and
- d. the transfer of appropriate technologies.

The papers presented in the conference will cover several areas including building materials in the region, research characterization, biocomposite and resins, technologies and different projects.

May I take this opportunity to ask Professor Meriani to say a few words before the Guest of Honour delivers the opening address.

OPENING SPEECH BY THE ARUSHA REGIONAL COMMISSIONER, HON. DANIEL OLE-NJOO LAY AT THE OPENING CEREMONY OF THE INTERNATIONAL WORKSHOP ON DEVELOPMENT OF NATURAL POLYMERS AND COMPOSITES IN EAST AFRICA

Mr. Chairman, the Director General of TIRDO, Col. Dr. Asifa P. Nanyaro, Professor Sergio Meriani, the Consultant, New Materials Program, ICS-UNIDO, Distinguished Guests Workshop Participants Ladies and Gentlemen

Let me, at the outset, express my very sincere and profound gratitude for having been accorded this opportunity and honour to officiate at the opening ceremony of this important workshop on Development of Natural Polymers and Composites in East Africa.

But before I dwell on the subject at hand, allow me, on behalf of the Government to extend a very warm welcome to all who are coming from outside Tanzania, especially Prof. S. Meriani, new materials consultant with International Centre for Science and High Technology (ICS). I hope you will have the time to visit some of our tourist attractions in the country before you leave and that you will find your stay in Arusha and Tanzania in general not only enjoyable but also memorable.

Mr. Chairman

I am told that this workshop is part of the project on materials design and selection for low cost housing in Africa and South West Asia. ICS previously organized a number of activities including expert group meetings, international training course and workshops aimed at transferring technologies that use natural fibres and materials, and recycle industrial wastes for cheap and sustainable engineering materials for developing countries. The previous efforts proved that it is necessary to get together some sub regional experts in the fields of biocomposite materials to exchange experiences and ideas with international experts. I am informed that the workshop draws 24 participants. They are coming from Italy and the Netherlands representing international experts and sub regional experts from Kenya, Namibia, Uganda and Zimbabwe. The Tanzanian academicians and practitioners in the field are equally sharing the experiences with their counterparts.

Mr. Chairman,

It is my belief that the workshop will aim at obtaining comprehensive databases on available natural resources and existing technologies and production systems in the region and provide opportunities to link local industries and research institutions. This will promote the realization and introduction of locally developed biocomposite materials to the construction industry.

Mr. Chairman,

In the Human Settlements Development Policy, the Government of Tanzania made clear that for building materials industry to play a major role in the economy, the choice of technology in the construction of housing must be made on the basis of the following criteria:

- (i) The use of locally manufactured or processed building materials especially where their production process is appropriate to our situation.
- (ii) Building of processes that encourage adoption of appropriate technologies and combine the use of semi-skilled and unskilled labour.
- (iii) The use of mechanical plant and machinery where this is proved to provide a cheaper and efficient service without compromising job opportunities. The award of contracts from the public sector include small contractors with proven threshold levels of resources and technical skills necessary for the job at hand and with appropriate management and financial responsibility capacities.
- (iv) The award of contracts from the public sector include some contractors with proven threshold levels of resources and technology skills necessary for the job at hand with appropriate management and financial responsibility capacities

Further, the Government encourages the use of local building materials in public housing schemes and private investment in building materials production.

Mr. Chairman,

I understand that the Tanzania Industrial Research and Development Organization (TIRDO) has carried out various research activities with local institutions such as University of Dar es Salaam - Materials testing section and foreign institution like Forintek Canada Corp. in the field of composite materials. The research outputs by TIRDO showed that tannin based wood adhesive applicable to the manufacturing of particleboard and plywood has superior product characteristics than conventional adhesives in use. Industrialists may take this opportunity to make use of the research results.

Mr. Chairman,

What I have mentioned above is just a tip of iceberg but the expected outputs are: -

- availability of databases of natural fibres and resins in the region

- Technical appraisal of existing biocomposite technologies
- Linkages of stakeholders in the biocomposite materials technology
- Awareness creation and dissemination

Mr. Chairman,

The Government understands that it is a costly exercise to bring together such an audience. I therefore, like to pay tribute to the United Nations Industrial Development Organization (UNIDO) for providing financial support for this workshop. Also, I extended my appreciation to ICS of Italy for its continual coordination of the biocomposite material program in the sub region.

Finally, let me assure you of the Government of the United Republic of Tanzania's full co-operation and support in the endeavours of converting natural materials into applicable housing inputs. This way, not only shall we be able to sustain industrial development, but also I am sure our resources will be deployed sustainably and equitably for the good of our people and the world at large.

Mr. Chairman,

Ladies and Gentlemen, with these few remarks, it is now my pleasure to declare the workshop on Development of Natural Polymer and composites in East Africa officially opened.

Thank you for your attention and I wish you all the best in your deliberations.

REMARKS BY MR. FELIX UGBOR, UNIDO REPRESENTATIVE AT THE CLOSING CEREMONY OF THE INTERNATIONAL WORKSHOP ON THE DEVELOPMENT OF NATURAL POLYMERS AND COMPOSITES IN EAST AFRICA (ARUSHA, 27 SEPTEMBER, 2000)

Mr. Chairman, Director General of TIRDO Dr. A.P. Nanyaro,
Prof. Sergio Meriani, ICS Consultant,
Distinguished Workshop Participants,
Ladies and Gentlemen,

It is indeed a great honour for me to be with you at the closing ceremony of the three-day workshop at which you discussed various

issues related to natural polymers and composites. I should therefore like to express my thanks to our hosting institution, TIRDO, for inviting me to officiate at the closing ceremony.

I have a feeling that the organizers choose Arusha as the venue of the workshop not only because of its beautiful weather but because, away from the hustle and bustle of Dar es Salaam, the cool environment of Arusha allows one to do serious jobs. Indeed, finding ways of providing affordable, decent and durable shelter for the growing population, is a serious matter. Obviously, the application of natural polymers and composites in the provision of shelter deserves attention. In other words, Mr. Chairman, I consider the issues you have been addressing in this workshop as timely, topical and extremely relevant.

Mr. Chairman, my acceptance of your invitation was informed by three issues

- i) The obvious is that ICS is an establishment set up by UNIDO, using funds from the Italian authorities.

In my capacity as the UNIDO representative, it is important that I should identify with the important work you are doing here.

- ii) Secondly, as stated earlier, the theme itself is evidently important and links directly to the Human Development Settlement Policy recently approved by the Tanzania Government. The UN system has the responsibility to help the Country realize its overall objective of alleviating poverty in the country. The provision of affordable shelter is certainly of interest to the UN system (UNDAF at Bagamoyo).

- iii) Thirdly, following the India-UNIDO exhibition of technologies and materials for low cost housing at the 24th Dar es Salaam International Trade Fair held in July this year, I initiated series of meetings that have been looking into ways and means of internalizing the technologies/experiences of Indian. As of now, a draft memo of understanding between India and Tanzania has been prepared. A draft programme is in the

making –hopefully to be funded by same donors.

I clearly see the link between the initiative I started and the essence of this workshop.

In fact the third meeting was held last week (21 September, 2000) and participants were drawn from BRU, IPI, National Construction Council, Board of Architects, Construction Companies, CTI, Ministry of Housing, etc. It was a deliberate effort on our part to have a mix of stakeholders-public and private, in other to draw up a credible shelter support programme. Only yesterday, I held discussions with the newly appointed executive Director of Habitat, Prof. Anna Tibaijuka. She expressed the desire to have Habitat play its role in what I would call “movement for affordable housing”

Mr. Chairman, we all agree that shelter is a basic need. Owning a home is a lifelong dream of everybody because it brings with it pride of ownership, sense of security and a feeling of control and freedom. But we are at a critical juncture for the world's urban areas. Urbanization has been proceeding at a rapid pace the world over, especially in the developing countries. It has been projected that 600 million people will be added to the world's urban areas within this decade of the millennium. The world would soon have 21 megacities, each having population 10 million and above. Seventeen of these megacities will be in the developing countries.

Here in Africa, the expansion of urban life is putting new and greater demands on the continent's construction industry.

It is reported that Africa spends over US\$ 3 billion annually on imports of building materials. Apart from the fact that these imports do not meet Africa's needs, the foreign exchange outflow further strains the worsening balance of payment situation.

Some of the factors that have been identified as contributing to inadequate housing/shelter include;

- high cost of conventional building materials
- inadequate supply of durable building materials at affordable prices.

- Lack of information and knowledge about locally available building materials.
- Inadequate infrastructure – roads, electricity and water
- Lack of financing schemes and mechanisms, etc.

Mr. Chairman, in an effort to address these and other problems, the Government of Tanzania has adopted the National Human Settlement Policy. It is my submission however, that to realize the objectives set out in the policy document, a more broadbased approach needs to be instituted. Various interest groups and stakeholders must be involved.

In this connection, I would like to see this workshop as one of stocktaking. It is clearly consistent with UNIDO view that one major option for solving our housing problem would be to promote the use of natural polymers and composites based on local resources from forestry, agriculture, natural fibres, plant materials and agricultural/industrial wastes.

I recognize and appreciate the effort to involve some private/business people in your workshop. This is indeed a good approach. Nevertheless it is my hope that your future workshop would include policy makers, financial institutions, architects, designers, etc. The establishments dealing with environment need to be involved also.

Mr. Chairman, I looked through the impressive list of participants. It is noteworthy that they are drawn from various countries including Tanzania (the host), Namibia, Kenya, Uganda and of course our experts from Italy. Such wide participation would have enabled you to share experiences from various countries.

I also worked at the topics on which presentations have been made. They are topical and link one with the other.

Looking at the future, I believe you have examined the necessity of a regional approach, which enables the participating countries (and others), to build on what you have learnt in the three days. Moreover, a regional approach would help the countries to continue sharing experiences. In this connection, I am told that you also considered,

rightly too, the need to develop a harmonized database.

Based on the above (and the outcome of this workshop), I would still urge for a comprehensive and integrated approach to the promotion and application of technologies and composite materials in support of low cost housing. You have made a wonderful start that needs to be nurtured and sustained.

In concluding, I would like to pay tribute to each and every one of you for giving of you time and knowledge. Special thanks go to Dr. Nanyaro and staff in TIRDO. You exceeded your undertaking to run this international workshop.

On that note, Mr. Chairman, Ladies and Gentlemen, it is now my honour and privilege to declare the workshop closed.

Thank you.

Annex 10: Actual expenditure

	Description	Unit	Qty	@	Cost
1	Travel Europeans	Each	3	1,200	3,600
2	Travelling regional	Each	20	535	10,700
3	DSA	Man-nights	108	125	13,500
4	Conference venue	Days	4	250	1,000
5	Visits	Days	1	310	310
6	Stationery etc			1,200	1,200
7	Telecoms			480	480
8	Secretarial support	Man-months	4	800	3,200
					33,990

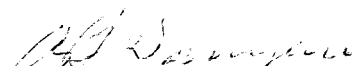
Financial statement

UNIDO Project Number: TF/GLO/000/105

Contract Number: 2000/T181

First installment from UNIDO	27200
Total actual expenditure	33,950
Outstanding Balance	6750

I certify the above statement is correct



Name: Dr A.P. Nanyaro
Position: Director General



Name: Mr J.G. Komba
Position: Accountant

Annex 11: Materials selection and design for housing in developing countries

Prof. Sergio Meriani

Scientific Advisor, ICS-UNIDO

Background

The scope of the New Materials activities has been to stream materials science and engineering into applied research with the final goal of contributing to the development of less industrialized countries. More recently, the scope has been approached through new concepts about materials resources as the integration of renewables and by-products into the overall materials cycle.

Two meetings were held recently in India the Training Course on "Building Ceramics from Industrial Wastes" held in Trivandrum, Kerala, March 22-26, 1999 in cooperation with the Council for Science and Industrial Research of India (CSIR) and the Conference on "Waste Based Construction Technologies" in cooperation with the Building Materials Technology Promotion Council (BMTPC), New Delhi (India) 13-16 April 1999.

Various experiences, different problems and case-studies were presented to establishing an inspiring landmark for the advancement of the integrated materials cycle approach for the exploitation of raw materials and natural resources. It has been also pointed out that a sustainable growth of the quality of living in every part of the world should be based on the philosophy of *"using less and less non-renewable resources, turning by-products into secondary raw-materials and goods"*.

The final recommendations of the meetings can be summarized as follows.

- (1) Ever growing requirements of housing and infrastructure in the developing countries lead to exponentially rising demand and severe shortages of cost-effective building materials.
- (2) Materials industry for housing and building sector in most developing countries has increasingly become dependent on import of

materials and in several cases even import of raw materials.

(3) Manufacturing methods based on capital intensive technology are not feasible to meet the need of building materials in many African and south-east Asian countries. There should be a shift from fired to unfired materials, in recognition of the vital importance of energy conservation in the building materials sector.

(4) To achieve the objectives National Governments need to promote productivity as well as bridge the gap between research findings and wide-scale application by promoting investment and technology transfer amongst the developing countries of Africa and South-East Asia.

(5) The international agencies like World Bank, UNDP, UNEP, should be requested to encourage technology sharing, training in new production methods, and set up demonstration projects jointly with established formal and informal sector producers for disseminating information on improved production methods.

(6) ICS-UNIDO has been requested to support the organizations of such Research-Industry get-togethers, in the form of Workshops, Training Courses and Conferences in which researchers and policy makers of the various countries may contribute to sort out and transfer the most appropriate technology in the building materials sector.

Objectives

The present Workshop is focussed on the scientific and technological prerequisites of a project proposal in the field of the composite materials based on natural resources to meet the rising demand of building materials based on local renewable resources and on by-products from industry, forestry, agriculture, etc. This option calls for a detailed data base

generation analysis of the current and alternative building materials, in order to analyse and compare the respective life-cycles.

Expected output

To present projects suitable for designing composite materials for civil engineering applications, infrastructure and housing, with special emphasis on the natural fibers and natural resin composites suitable for the low-cost housing programmes.

To introduce the basis of life-cycle analysis and to present concepts and techniques of decision support systems applicable to this field.

To meet the scope of ICS and UNIDO, a comprehensive programme of cooperation among selected countries of Africa and Austro-Asia should be prepared and forwarded for evaluation to the International Investment Agencies.

Previous activities of the New Materials in the years 1997- 2000 before this workshop.

An Expert Group Meeting on "Composite Materials and Waste Minimization" took place in Trieste (Italy) 13-15 November 1996 with the aim of planning a medium term programme for the years 1997-99

In the year 1997

1) Workshop on "Composite materials, waste minimization, technology management" Bergamo (Italy), 3-7 March 1997

2) Workshop on "Composite materials based on natural resources", Dar Es Salaam (Tanzania), 4-8 August 1997.

3) Training course "Building materials based on fly ash and industrial waste resources", Shanghai (China) 3-13 November 1997.

In the year 1998

4) Expert Group Meeting on "Resources and Technologies for Waste Valorization" Trieste, Italy, 26-27 February 1998

5) Training Course on "Best Available Technologies in Ceramic Production" Modena, Italy, 22-26 June 1998

6) International Workshop on "Technological and Management Aspects for Recycling and Reuse of Solid Waste in Latin America" Monterrey, 5-9 October 1998

In the year 1999

7) Training course on "Building Ceramics from Industrial Wastes" held on in Trivandrum, Kerala, March 22-26, in cooperation with the Council for Science and Industrial Research of India (CSIR)

8) Conference on "Waste Based Construction Technologies" in cooperation with the local Building Materials Technology Promotion Council (BMTPC), New Delhi (India) 13-16 April 1999

9) Workshop on "Materials selection and design: for housing in developing countries" held in Trieste, by ICS at the Area Science Park - 16-20 November 1999.

In the year 2000

10) Training Course on "Best Available Technologies for Ceramic and Glass-ceramic Production" held in Modena, Italy, at the Demo Center, 6 June – 1 July, 2000.

Concluding remarks

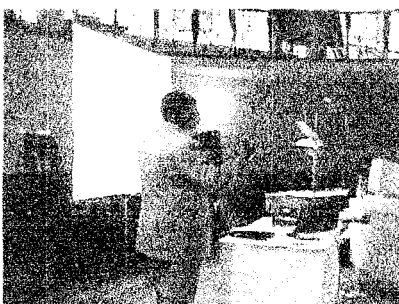
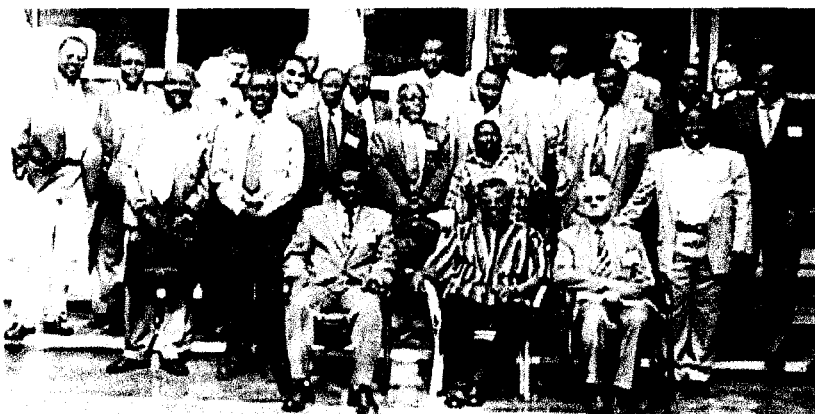
In order to fulfill objectives of the ICS-UNIDO, current research efforts should concentrate on applied research and commercialization of natural composites to produce cheap building materials, using local materials and affordable technologies. The participants of this meetings should encourage entrepreneurs to help the undertaking and dissemination of appropriate technologies in housing and building materials.

The South-to-South cooperation should be emphasized to enhance research and transfer of appropriate technology. With this purpose in mind, research on further functionalization of CNSL, to make renewable materials and products, has been encouraged by the ICS-New Materials line to the point of realizing a network including a tripartite cooperation in the whole region of East-Africa.

Annex 12: Some photographs of the Workshop



Above: Participants chatting during tea break. **Below:** Group photo with guest of Honor, Mr Ugbor after the closing ceremony.



Left: Presentation in a typical session.