INTERNATIONAL CENTRE FOR SCIENCE
AND HIGH TECHNOLOGY

FINAL REPORT

Workshop on "Industrial Utilization of Pyrethrum"

Dar-es-Salaam, Tanzania
29-30 May, 2000

organized by

ICS-UNIDO

in collaboration with the

UNIDO FIELD REPRESENTATION
Dar-es-Salaam, Tanzania

WORKSHOP ON INDUSTRIAL UTILIZATION OF PYRETHRUM

The International Centre for Science and High Technology (ICS) in collaboration with the UNIDO Representative's office in Dar es Salaam hosted a two day workshop on industrial utilization of pyrethrum from 29th to 30th May 2000, at Sheraton Dar es Salaam Hotel, Tanzania.

1.0 WORKSHOP OBJECTIVES

The workshop brought together experts engaged in agricultural production and industrial utilization of Pyrethrum to:

- assess the present status and formulate future strategies that would promote pyrethrum production in the East African region.
- explore more effective production technologies, marketing strategies, research needs and quality improvement measures for the pyrethrum crop.

2.0 OUTLINE CONTENT

The following papers were presented and discussed during the workshop:-

- Pyrethrum's Industrial potential: Research Overview.
- Pyrethrum Production in Tanzania
- Industrial Processing of Pyrethrum in Tanzania
- Marketing of Pyrethrum in Tanzania
- Pyrethrum – in retrospective and prospective
- Pyrethrum Production and Industrial utilization in Kenya
- Pyrethrum Production and Industrial utilization in Rwanda
- New opportunities for National pyrethrum products in Europe.

3.0 PARTICIPATION AND WORKSHOP PROGRAMME

The workshop programme and list of participants are annexed to these notes.

4.0 Day one : PLENARY SESSION.

4.1 Opening of the workshop

The workshop was formally opened by Mr. Reginald Mengi, Chairman of the National Environment Management Council.(NEMC)

Introduction and general house-keeping matters were presented by Mr. Felix Ugbor, UNIDO Representative. He welcomed the participants to the two day forum and went on to introduce Dr. John Liwenga, the current Chairman of the Tanzania Pyrethrum Board, outlining that he was to moderate and chair the workshop.

Dr. John Liwenga: took the chair and went on to invite Mr. F. Ugbor for the opening remarks.

He called on the participants to come up with recommendations that will enhance pyrethrum production and industrial utilization for the economic benefit of the poor rural farmer and for the conservation of the environment.

Mr. Mengi further congratulated UNIDO and ICS for oganising the workshop and called on the Governments of Tanzania, Kenya and Rwanda to create policies and incentives which will encourage cultivation and utilization of pyrethrum in their states as an environmental protection strategy.

He concluded his speech by wishing participants fruitful discussions and hoping that their recommendations will enhance pyrethrum production and its industrial utilization in the East African region.

4.2 **Presentations.**

Paper 1: Pyrethrum's Industrial Potential : Research Overview

(Prof: J. H.Y Katima Department of Chemical and Process Engineering, University of Dar es Salaam)

The paper discussed the pesticide product line and its global consumption pattern, high lighting that about 85% of the world pesticide consumption is used in agriculture and about three quarters of pesticide use is in developed countries, it is nonetheless substantial and growing rapidly. In addition, the pesticides market in developing countries is dominated by insecticides with higher acute toxicity than herbicides which dominate in the developed countries.

Increasing concern for health risks associated with the "persistent organic pollutants" (POPs) and the recent world focus on protection of the environment, have produced tremendous interest in botanical pesticides especially pyrethrum which has been proved effective and less toxic to humans.

In recognition of this potential, a holistic review of the industry has to be made in order to optimise yields and hopefully maximise production. The proposed review should take into account the farming, harvesting, handling of fresh flowers, drying, extraction of the product, purification of crude extract, formulation and marketing.

In conclusion he underscored the importance of pyrethrum as an insecticide by listing its outstanding properties which include:

- Rapid action
- Low mammalian toxicity
- Lack of insect immunity
- Broad spectrum of activity
- Environment friendly – non resistant

Following the increase in pyrethrum production the need for additional processing capacity became evident in the 1970s' New extraction facilities were installed at Mafinga in the Southern highlands, where 70% of total production of flowers was being cultivated. The new plant went into commercial production in 1982 and had a capacity of 4500 tonnes per annum.

While the Arusha plant is no longer operational due to low production of pyrethrum flowers in the region, the Mafinga plant was privatized in 1998 and currently operating under the name of Tanzania Pyrethrum Processing and Marketing Co. Ltd (TPPMCL), a subsidiary of International Chemical Producers of South Africa.

He went on to discuss the manufacturing processes at TPPMCL. The process employs organic solvents to leach flowers to produce crude pyrethrum extract and pyrethrum dry marc. This was followed by a detailed description of unit operations and process stages including.

- Flower reception and storage
- Milling
- Extraction
- Evaporation
- Finished product handling/storage
- By product handling/storage

On plant efficiency Mr. Swai elaborated that recovery at TPPMCL factory currently lies between 85 and 90 per cent. Since plant efficiency depends on pyrethrin content of the feed, farmers are encouraged to supply high quality flowers.

He concluded his presentation by thanking ICS and UNIDO for organising the workshop.

Paper 4: Country paper (Kenya)

(R.K. Shah, Managing Director, Coil products Ltd.)

In his introduction Mr. Shah highlighted man's continued need to control harmful insects. Man has been protective to himself, his crops, his food reserves and his animals. He is in perpetual need of suitable insecticides. Suitability here refers to:-

- High degree of biological efficiency
- Low environmental impact
- Minimal risks from its use to non target insect species and animals
- How inanition toxicity pyrethrum has long been considered the safest insecticide above all others in terms of safety and toxicity. It has been the ideal choice of active ingredient for insecticide manufacturers and to the end users of household insecticides.

The paper further gave an outline of primary products of pyrethrum processing i.e. pyrethrum extract, powder and marc. Uses of these products were also discussed by the presenter .

Mr. Shah finally dwelt on the marketing of their pyrethrum products and noted the following:

- the local market is centred on mosquito coils, as they are readily available relatively cheap and effective in repelling mosquitos.
- Aerosols, vermin powder and vapour mats are predominantly used in middle and upper class homesteads
- The company exports mosquito coils to Tanzania, Uganda, Sudan, Zimbabwe, Malawi and Japan.
- It has however been difficult to top the American and European markets owing to the high cost of obtaining the requisite registration of finished products'
- Almost all of the pyrethrum extract produced in this region is exported to America and Europe. Total demand surpasses current production.
- Local processors should strive to sell abroad finished products and not crude extract.
- The East African market is flooded with imported products from all over the world. These products are formulated using synthetic ingredients and hence cheaper than locally manufactured products.

Paper 5: Marketing of Pyrethrum in Tanzania

(Mr. Edward J. Materu, Former marketing Manager Tanzania Pyrethrum Board)

Mr. Materu started with an overview of the world's production of pyrethrum, listing Kenya, Rwanda, Tanzania and Tasmania as the world's leading growers of this commodity. Small amounts are currently being grown in Papua New Guinea, Ecuador, India and most recently Uganda.

Most of these countries export over 80% of their produce largely in the form of crude extract. USA is the largest importer of pyrethrum products. In the East African region, it is only Kenya and Rwanda who have refineries. Another notable product from pyrethrum is "ground flowers in powder form", an important raw material for mosquito coils manufacturers.

Currently the world demand for pyrethrum stands at 20,000 tonnes of dried pyrethrum flowers per annum. World preference for use of organic and natural insecticides, predicts further increase in world demand for pyrethrum. The paper on to discuss the current product mix offered by the Tanzanian based pyrethrum processors namely:-

- Pyrethrum extract (concentrate): 98% is exported to the world's largest consumer – USA
- Pyrethrum extract (standard): which is traded locally in small quantities for application in farm sprays.

- Super fine pyrethrum powder: is exported mainly to Japan and the Far East, a substantial amount is also sold locally to mosquito coils manufacturers.
- Dry pyrethrum marc: is also exported, but a larger portion is traded locally mainly in ranches. (An appropriate mix of dry marc and maize bran is good cattle feed)
- Apart from the Mafinga based pyrethrum extraction plant, Tanzania has only one formulator/producer of aerosols (Mansoor Daya Chemicals Ltd) and one manufacturer of pyrethrum based mosquito coils (Dawa ya Mbu Ltd)

This was followed by an account of RWATAKE - a regional grouping made up of pyrethrum stake holders from Rwanda, Tanzania and Kenya which meets regularly to exchange notes on production, pricing, marketing and other related issues pertaining to pyrethrum development in member states.

Mr. Materu concluded his presentation with a call to farmers to grow more of the commodity along with investments in processing facilities, refinery and aerosol manufacturing plants. Research should also be encouraged in ascertaining the wider use of pyrethrum marc in fighting the stalk borer in maize, as already exhibited by farmers in the vicinity of Mafinga extraction plant.

Paper 6: Country paper (Rwanda)

(Mr. Sylvain Nzabagamba, Managing director OPYRWA, Rwanda)

Pyrethrum was introduced in Rwanda soon after the world war by the Belgians. In 1968 a farmers cooperative society (ASPY) was established followed by an extraction plant (USINEX) in 1972. Prior to that bales of dried pyrethrum flowers were being exported to Kenya for processing.

Pyrethrum production registered significant growth from 1174 tons in 1972 to 1500 tons in 1976. To sustain this increase in production ASPY and USINEX merged to form OPYRWA. Assisted by UNIDO the new organisation built a refinery in 1978.Due to defective designs the refinery has never been operational.

The paper went on to highlights the rise and fall of pyrethrum production in Rwanda between 1978 and 1993. Major constraints were cited as:- low producer prices, delayed payments to farmers, lack of good planting material and lack of appropriate agronomical research. The genocide in 1994 was another cause of lack of production between 1994 and 1998.

The pyrethrum Board in Rwanda (OPYRWA) is currently focusing on revamping the pyrethrum sector in Rwanda. To start with, it is providing good clonal material and establishing nurseries. Producer prices have been reviewed upwards and agronomists recruited to provide extension services to farmers.

He went on to conclude his presentation with a call to UNIDO for assistance in terms of

- Selection of good planting clones of high yield strains
- Multiplication of clones and finally distributing them to formers

- Rehabilitation of drying facilities, refurbishing of the extraction plant and the refinery.

Paper 7: Pyrethrum - in retrospective and prospective
(Dr. Karan Vasisht,Scientific Consultant, ICS Trieste Italy)

The paper covered various aspects of pyrethrum, starting with its origin, its chemical constituents and the most common pyrethrum products, namely powder, crude extract and pure pyrethrum extract. The paper went on to discuss key pyrethrum insecticidal properties, namely:-

- Quick knockdown effect
- Repellent in very low concentrations
- Very low mammalian toxicity
- Low incidence of insect resistance
- Very short life in environment and quick biodegradation

Other positive aspects of pyrethrum were highlighted , namely, safety ratio to mammals, non polluting to food and water chains and environmentally friendly. This was followed by an account of pyrethrum uses, and leading twelve producers of pyrethrum in the world. The impact of synthetic insecticides on the environment and human health was also noted.

Emphasis on botanical insecticides, world preference for use of organics and the need for friendly insecticides are new prospects for pyrethrum based products.

In its conclusion the paper dwelt on problems besetting the pyrethrum sector and what needs to be done to overcome them. The paper layed strong emphasis on the following:-

- Provision of high yield clones, access of farmers to improved seeds and saplings, better drying, storage and extraction techniques.
- Processing and refining facilities at source, product development and innovation.
- Liberalized marketing policies with more returns to farmers

Paper 8: New opportunities for natural pyrethrum products in Europe.
(Vittorio de Rinaldini, Marketing Expert, Milan Italy)

The paper discussed the origin and development of new marketing opportunities for pyrethrum based products which are fast appearing in Europe. They are a direct result of the renewed and growing demand for natural products and those produced in a natural way (i.e. by biological production methods)

Pyrethrum being a natural product, its use is allowed in the cultivation of fruits and vegetables under biological production methods. It is looked upon as an insecticide of natural origin and cannot be compared with products of different origins -even if at the end of the day, they have the same function. This has generated additional demand for pyrethrum where public opinion is getting more sensitive to solutions which look after the environment and public heath.

In its conclusion the paper observed that there are new opportunities for pyrethrum in Europe and they offer great growth potential. They need to be nurtured and not destroyed. The only obstacle in our way is the limited availability and high cost of natural pyrethrum. A positive response from producing countries to this stimulus, is to maximise production

Plenary Discussion

After all the eight papers were presented, the Chairman invited workshop participants to discuss various issues raised in the presentations. Contributions/observations from participants were as follows:

Improved seeds

Availability of high yield planting materials would maximise output and generate more income to the farmer.

Processing efficiency

An observation was made that the existing processing facilities at Mafinga need to be upgraded as a measure towards enhancing processing efficiency and reducing costs.

Producer prices

The rationale for farmers in the north of Tanzania getting a far better price than those in the south was queried by participants. The crux of the problem is the growing dissatisfaction and the impact it might have on pyrethrum farming in the South. Two participants, both of them farmers, called for a price review that will ensure more financial returns to pyrethrum farmers.

Extension services.

Lack of regular and adequate support to farmers in good crop husbandry, especially in regions were pyrethrum is not major cash crop was another serious constraint which was observed by several participants.

Pyrethrum Research

Supportive research is non existent. This was attributed to understaffing, inadequate funding and lack of research facilities.

Driers

A suggestion was made by one participant that mobile driers should be reintroduced so as to cut down drying time and improve product quality. Another participant wondered if sun drying of flowers was not facilitating excessive loss of pyrethrins!

Strategic planning

There is growing demand for pyrethrum worldwide. One participant asked if stakeholders are ready to take up the challenge of producing more to meet demand. He called on participants to identify existing bottlenecks and formulate appropriate solutions that will maximise production.

Technical assistance.
One participant suggested that we should identify our problems first, and then decide on what we want to achieve before seeking technical assistance externally.

Commercial farming
The UNIDO Representative was of opinion that improved production methods should be at the centre of any meaningful plan for pyrethrum development. He went on to suggest commercial farming of pyrethrum.

RWATAKE spirit
One participant called on Rwanda, Kenya and Tanzania to enhance corperation and shy away from the notion of being potential competitors in the pyrethrum industry. World demand is far greater than the total combined production of these countries and unlikely to change in the near future.

- The Pyrethrum Board was called upon to take the lead in setting up, organising, augmenting research for the entire industry.
- A suggestion was made that a system of collecting information pertaining to the industry should be established. Same could be forward to ICS for publication and dissemination.
- The UNIDO Representative informed the workshop that he was soon going to invite proposals on viable investment projects, particularly agro-processing.

DAY TWO:

5.0 ISSUES RAISED DURING GROUP PRESENTATIONS

Group A: Agriculture

The group made the following observations:
- Production has been declining from 6000 tonnes in 1966/67 to 1000 tonnes end of this season.
- The are 2000 registered farmers in the southern highlands who are in 200 PGAs and primary societies, cultivating 8000 ha.
- In the northern highlands, there are 240 registered farmers working on 120 ha.
- Apart from the southern highlands, pyrethrum cultivation can also be introduced in new areas such as Uwino in Ruvuma, Kasulu in Kigoma and some parts of Kagera region.
- The pyrethrum sector is currently faced with the following constraints:
  - Lack of supportive research
  - Lack of extension services
  - Lack of high yield planting materials
  - Inefficient drying techniques
  - Poor storage and transportation facilities
  - Low producer price

Group B: Processing

The group addressed itself the to the following questions: "In regard to the Mafinga extraction plant - is the current achievable capacity of 3000 tonnes of dried pyrethrum fully utilized? Could the extraction capacity be a bottleneck if we think of sensitizing farmers to grow more pyrethrum?"

In answering these two questions, the group made the following observations-

- There is inadequate supply of flowers to the plant
- Poor quality of flowers (low pyrethrins content, fermented and caked)
- Dilapidated plant machinery
- High solvent consumption
- Inadequate percolation cycle.
- Design inadequacy
- High production cost
- Process limited to only two products (crude extract and dry marc)
- Low pyrethrins in extract
- High pyrethrins levels in dry marc
- Inadequate use of existing national research institutues
- Lack of R&D facilities at factory level

Group C: Marketing

The group made the following observations:-

- Pyrethrum market is huge and fast growing
- There is inadequate supply of pyrethrum on the world market .
- Prices are good, emphasis should be on agriculture to improve production.
- There is a need to explore new markets especially in the Far East.
- There is inadequate product development and innovation
- The local market is flooded with cheap, substandard products made from synthetic pyrethroids
- The local market is not fully liberalized, it has very few dedicated players.

6.0 WORKSHOP CONCLUSIONS AND RECOMMENDATIONS.

Pyrethrum is an ideal insecticide in today's context. It is produced from natural source, has safety to mammals and does not leave harmful residue in the environment. These characteristics make pyrethrum safe and environment friendly insecticide. World preference for use of plant derived products has further augmented interest in pyrethrum. Interestingly, 90% of world production is achieved in the East Africa region of Kenya, Tanzania and Rwanda which exports 85% of its produce to the world market.

The estimated present demand for pyrethrum stands at 20,000 MT per annum of dried flowers against current world production of less than 12,000 MT. The concern for declining trend of pyrethrum production in these countries despite increasing world demand prompted ICS-UNIDO to organize a two-day workshop in Tanzania to promote production and industrial utilization of pyrethrum in East Africa countries. The workshop was organized by ICS in collaboration with country UNIDO Office in Tanzania. The experts from Industry, academia, agricultural sector and farmers association participated to deliberate on different issues involved in the production of pyrethrum, a crop which can have profound effect on the economy of East African countries.

Key issues were discussed at length and experts agreed to make the following recommendations to be taken up for follow-up at different levels.

6.1 There is an immediate need to revamp pyrethrum industry by increasing agricultural production to tap fast expanding world demand.

6.2 All possible help should be rendered to farmers to increase production and yield per hectare from the current 250 kg/ha to 500 kg/ha and pyrethrins content from the present 1.2% to above 2.0%.

6.2.1 To achieve this, research should be encouraged to multiply suitable clones through tissue culture facilities, which should amply be supported by bulking centres with green houses located at strategic places managed by contract farmers on commercial basis.

6.2.2 Farmers should be motivated to increase overall production through :

- Access to improve planting material on credit
- Better producer prices
- Prompt payments to farmers and
- Timely analysis of their produce to facilitate payment of the 2nd installment.

6.3 Extension services should be strengthened to include awareness programmes and farmer education on crop management using radio, television, documentaries, and print media. The farmer should be conveyed the importance of :

- Picking the flowers at the right time
- Using better drying techniques to prevent loss of pyrethrins.
- Using proper packaging and packing material to avoid fermentation and loss of pyrethrins during transport.

- Effecting timely deliveries at processing centres.
- Extension staff should be motivated through incentives and good remuneration.

6.4 The current achievable capacity at the only processing plant in Tanzania is 3000 MT per annum of dried pyrethrum flowers. However, the 20 year old dilapidated plant is based on old conventional technologies which employ larger quantities of organic solvent to leach flowers. High solvent consumption results into high production costs and hence less money to the farmer. The workshop recommended the following:-

- Rehabilitate the existing plant.
- Adopt new and cleaner production technologies.
- Monitor closely process operations for improved efficiency
- Put in place preventive maintenance measures as well as human resource development programmes.
- Ask the government to review taxes and utility tariffs in favour of the industry.
- Expand existing processing facilities and / or encourage new investments to include diversification of products e.g. (powder, refined extract, formulated products, cattle feed and manure)
- Encourage the use and strengthening of existing R& D facilities in the country.
- Establish R&D centre at the processing plant.

6.5 Although the present supplies are inadequate to meet current world demand, new markets must be developed to absorb envisaged increase in production in future. The workshop recommended to :

- Strengthen existing markets in the West and identify new markets in Asia and the Far East.
- Encourage local consumption of pyrethrum based products by popularizing its advantages over synthetic insecticides.

6.6 As 90% of world production is located in Kenya, Tanzania and Rwanda, there is a need for closer cooperation among these countries in areas of research, product development, marketing and development of improved processing technologies. These countries should develop uniform quality bench marks for pyrethrum products in conformity with latest world standards.

6.7 The existing research and development facilities in these countries should be strengthened to develop:-

- High yield synchronous clones
- Complete agronomical packages.
- Improved processing technologies
- High tech pyrethrum products for markets in developed countries.
- Low cost drying techniques like solar dryers.

PAPERS PRESENTED DURING THE WORKSHOP ON INDUSTRIAL UTILIZATION OF PYRETHRUM

1. Pyrethrum's Industrial Potential: Research Overview, by Prof. J. H. Katima
2. Pyrethrum Production in Tanzania, by E. R. Mhekwa, B. E. G. Kiwovele, G. M. Mbeyela
3. Industrial Processing of Pyrethrum in Tanzania, by Mr. W. Swai
4. Utilisation of Pyrethrum in Industry, Kenya Country paper, by Mr. R. K. Shah
5. Marketing of Pyrethrum in Tanzania, by Mr. E. J. Materu
6. Production of Pyrethrum in Rwanda, by Mr. N. Sylvain
7. "Pyrethrum-in retrospective and prospective", by Dr. Karan Vasisht
8. "New Opportunities for Natural Pyrethrum Products in Europe", by Mr. V. De Rinaldini

INTERNATIONAL CENTRE FOR SCIENCE
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Pyrethrum's Industrial Potential: Research Overview

Paper presented at the ICS-UNIDO Workshop
On Industrial Utilization of Pyrethrum
At Sheraton Dar-es-Salaam Hotel, Tanzania
29-30 May, 2000

By
Prof. J. H. Katima

PYRETHRUM'S INDUSTRIAL POTENTIAL

by

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A paper presented at the UNIDO Workshop 29-30 May 2000 at Sheraton Hotel, Dar es Salaam, Tanzania

1.0 BACKGROUND

Pyrethrum: A beautiful daisy that is hardy and blooms throughout the spring and summer. Its flowerheads are used to make probably the best natural pesticide available.[1]

It is a mark of pyrethrum's advantages "fast knockdown time, rapid environmental degradation and low mammalian toxicity"[2]

Pyrethrum, chemically breaks down into harmless compounds within 24 hours of application.[3]

1.1 Current Pesticide Spectrum and Global Use

Several hundred pesticides (active ingredients) are currently used world-wide. The Pesticide Manual [4] - contains a total of 759 chemical and biological pest control agents. Of which 33 have been classified as extremely hazardous to human health by the World Health Organisation (WHO Class Ia) [5], 48 as highly hazardous (Class Ib), 118 as moderately hazardous (Class II), and 239 as slightly hazardous (Class III). 149 pesticides were considered as unlikely to cause acute hazard in normal use (WHO Class IV). 164 of the Pesticide Manual's chemical entries have not yet been classified according to acute health hazard by WHO.

Figures on the global production of pesticides in terms of sales value are abundant, whereas information on production in terms of weight or volume of active ingredient is extremely scarce. The annual 'Production Yearbook' of the Food and Agriculture Organization of the United Nations includes data from only a very small number of countries. In addition, published figures are neither uniform in character nor updated regularly. FAO recently has initiated a Database on Pesticide Consumption [6]. This database is still at a very early stage. Nevertheless, the combined sales value in 1998 for the ten largest manufacturers (in decreasing order Novartis, Monsanto, DuPont, Zeneca,

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[1] http://www.msue.msu.edu
[2] John E. Casida and Gary B. Quistad. Oxford University Press, 1995.
[3] http://www.ecogrow.com/bugs.html
[4] C D S Tomlin (Ed)The Pesticide Manual – A World Compendium, Eleventh edition, British Crop Protection Council, 1997
[5] The WHO Recommended Classification of Pesticides by Hazard, and Guidelines to Classification 1998-1999, WHO/PCS/98.21, International Programme on Chemical Safety, Geneva, 1998
[6] http://www.fao.org/waicent/FAOINFO/economic/pesticid.htm

AgrEvo, Bayer, Rhone-Polenc, Cyanamid, Dow Agro and BASF)[7] was more than USD 27,000 million or 90% of the global sales value.

Of the world agrochemical market in 1995, USD 17,000 million out of USD 33,000 million (51%) were spent on generic (non-proprietary) pesticides. The global market for generics is estimated to increase to USD 27,000 million out of a forecasted total of USD 39,000 million (69%) by the year 2005 [8].

In 1995, world pesticide consumption reached 2.6 million metric tons of active ingredients with a market value of USD 38,000 million. Roughly 85% of this consumption was used in agriculture. About three quarters of pesticide use occurs in developed countries, mostly in North America, Western Europe, and Japan. Although the volume of pesticides used in developing countries is small relative to that in developed countries, it is nonetheless substantial and is growing rapidly. In addition, the pesticide market in developing countries is dominated by insecticides, with a higher acute toxicity than herbicides, which dominate in the developed countries [9]. In the mid 1990s, the estimated annual pesticide (active ingredient) use by region (in 1000 metric tons)[10] was:

Europe	800	(32%)
United States	500	(20%)
Canada	100	(4%)
Other industrialised countries	500	(20%)
Asia developing	300	(12%)
Latin America	200	(8%)
Africa	100	(4%)
TOTAL	2 500	

The world agrochemical market by crop at about the same [11] was:
Fruits and vegetables 26 %, cereals 15 %, maize 12 %, rice 10 %, soybeans 9.4 %, cotton 8.6 %, sugar beet 2.8 %, oilseed rape 1.6 %, and other crops 14 %.

1.2 Pesticides of International Concern

Rachel Carson, author of *Silent Spring* (1962), identified a number of pesticides causing adverse effects on the ecosystem ('Rachel Carson's Dirty Dozen')[12]. In 1985, the Pesticide Action Network launched a campaign called "The Dirty Dozen" to draw attention to a selection of hazardous pesticides. The original dozen now includes 19 pesticides [13]. A third 'dirty dozen' is the current group of 'persistent organic pollutants'

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[7] 1998 Top Ten Agrochemical Companies, PANUPS, Pesticide Action Network, May 7, 1999
[8] Uttley and Fairclough, AGROW No 301, March 27, 1998, p.14
[9] Source: World Resources Institute, Intensification of Agriculture; www.igc.apc.org/wri/wri/wr-98-99/agrichem.htm#trends
[10] Source: D Pimentel, Protecting Crops, pp 49-66 In: WC Olsen (Editor), The Literature of Crop Science, Cornell University Press, Ithaca, New York, 1995
[11] Source: AGROW No. 305, May 29 1998 p.19
[12] Bro-Rasmusen, Contamination by Persistent Chemicals in Food Chain and Human Health, The Science of the Total Environment 188, Suppl 1, 45-60, 1996
[13] PesticideAction Network, 1991.

(or POPs) identified by the United Nations Environment Programme [14]. This dozen includes 9 pesticides (and 3 other chemicals). A fourth group of potentially hazardous pesticides constitute the joint 'prior informed consent' (or PIC) initiative by UNEP and the Food and Agriculture Organisation of the United Nations, recently reshaped into the Rotterdam Convention [15]. The convention initially covers a selection of 21 pesticides. The three 'dirty dozens' and the PIC initiative together cover 39 pesticides of international concern (Table 1).

Box 1. Tendencies and forecasts in global pesticide use

1993	The last two years have seen a stagnation in the global agrochemical market [16]. The stagnant and stable market in the major pesticide consuming regions and lack of novel chemicals will increase the tendency in the agrochemical industry to look to export markets and sales in developing countries, particularly Latin America, Asia and the Middle East [17]
1996	World pesticide market expands. The South American market, particularly Argentina and Brazil, recorded the highest growth, with pesticide sales increasing 13%. Markets in Asia fell despite growth in China, India, Indonesia and the Phillippines. Africa's share of the world market shrank [18]
1997	Global agrochemical market up 1.3 %. Latin America was again the fastest growing region with an increase of 18%[19]. World agrochemical market growth slows down [20]

[14] UNEP Chemicals Newsletter 3(3), 1999
[15] Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade, UNEP/FAO, 1999
[16] Source: Pesticide Action Network Updates Service, January 12, 1994
[17] Source: Global Pesticide Market Review, Pesticide Action Network Update Service, January 12, 1994
[18] Source: Pesticide Action Network Updates Service, August 29, 1997
[19] source: AGROW No. 299, February 27, 1998, p.16
[20] Source: AGROW No. 305, May 29, 1998, p.18

1998	Global agrochemical market up 0.9%. Latin America was again the fastest growing region with a 12.5% increase [21]
1999	Global sales down 3.1 % [22]
2000	Global agrochemical market decline to continue [23]

[21] Source: AGROW No.323, February 26, 1999, p. 17
[22] Source: AGROW No. 345, February 4, 2000
[23] Source: AGROW No. 345, February 4, 2000

Table 1. Thirty-nine pesticides of international concern
* Pesticide considered to be obsolete/superseded/discontinued

Pesticide	"Rachel Carson's Dirty Dozen" (1962)	The Pesticide Action Network's "Dirty Dozen" (1985)	UNEP's POPs and ultimate goals for the international negotiations (1999)	Pesticides included in the Rotterdam Convention on Pr Informed Consent (1999)
Aldicarb	-	+	-	-
Aldrin *	+	+	Complete elimination	+
Amitrol	+	-	-	-
Binapacryl *	-	-	-	+
Camphechlor (Toxaphene)*	+	+	Complete elimination	+
Captafol	-	-	-	+
Chlordane	+	+	Partial elimination	+
Chlordimeform *	-	+	-	+
Chlorobenzilate *	-	-	-	+
Chlorpropham (CIPC)	+	-	-	-
DDT	+	+	Use limited to vector control	+
1,2-Dibromo-3-chloro-propane (DBCP) *	-	+	-	-
1,2-Dibromoethane (Ethylene dibromide, EDB)	-	+	-	+
Dieldrin *	+	+	Partial elimination	+
Dinoseb *	+	-	-	+
Endrin *	+	+	Complete elimination	-
Ethylene oxide	-	-	-	-
Fluoroacetamide	-	-	-	+
Heptachlor	+	+	Partial elimination	+
Hexachlorobenzene	+	-	Partial elimination	+

Pesticide	"Rachel Carson's Dirty Dozen" (1962)	The Pesticide Action Network's "Dirty Dozen" (1985)	UNEP's POPs and ultimate goals for the international negotiations (1999)	Pesticides included in the Rotterdam Convention on Pr Informed Consent (1999)
Hexachlorocyclohexane (HCH), mixed Isomers	+	+	-	+
Isobenzan (Telodrin)*	+	+	-	-
Lindane	+	+	-	+
Mercury Compounds	-	-	-	+
Methamidophos	-	-	-	+ [1]
Mirex *	+	-	Partial elimination	-
Monocrotophos	-	-	-	+ [1]
Paraquat	-	+	-	-
Parathion	-	+	-	+ [2]
Parathion-methyl	-	+	-	+ [3]
Pentachlorophenol	-	+	-	+
Phosphamidon	-	-	-	+ [4]
Propham (IPC)	+	-	-	-
2,4,5-T *	-	+	-	+

[1] SL formulations above 600 g/l
[2] all formulations except CS formulations
[3] EC formulations 19.5 % and above and dusts containing 1.5 % or more
[4] SL formulations above 1000 g/l

1.3 Areas of Major Concern

Synthetic pesticides are more of a threat to man than the insects it would seem. As each generation of insects become more immune the pesticide, stronger and more potent insecticides are released. A case example is the POPs which are characterised by their high stability in the environment (in other words persistent), potential bioaccumulation, toxicity and ability to travel long distances from potential sources. The health risks associated with POPs include cancers, birth defects, fertility problems, susceptibility to disease, and diminishing intelligence.

In August 1999, negotiators from 115 countries met in Geneva, Switzerland for the third round of United Nations-sponsored negotiations to develop an international treaty on Persistent Organic Pollutants (POPs). During the session, governments agreed to eliminate and phase out eight of twelve POPS chemicals targeted for action by the UN. Government negotiators in Geneva agreed to eliminate production and use of the pesticides **aldrin, endrin** and **toxaphene** without exemptions. They also agreed to phase out **chlordane, dieldrin, heptachlor, mirex** and **hexachlorobenzene**, but may consider limited country-specific exemptions. Significant controversy remains regarding elimination of the remaining chemicals on the list: PCBs, dioxins and furans, as well as the infamous pesticide DDT, which remains registered for public health purposes in approximately 20 countries. Negotiators also discussed criteria by which new POPs will be added to the action list, and technical and financial assistance for POPs phase outs and related activities.

It should be noted that aldrin, chlordane and heptachlor are registered for use in Tanzania. However, aldrin and chlordane are restricted while heptachlor is not. Dieldrin and toxaphene were withdrawn by registrants while mirex and endrin have never been registered for use in Tanzania.

2.0 NATURAL PRODUCTS

It can be seen that several pressures have accelerated the search for more environmentally and toxicologically safe and more selective and efficacious pesticides. It should be noted that most commercially successful pesticides have been discovered by screening compounds synthesised in the laboratory for pesticidal properties. The average number of compounds that must be screened to discover a commercially viable pesticide has increased dramatically. The increasing incidence of pesticide resistance is also fuelling the need for new pesticides. Thus, natural compounds, mainly of plant origin, have increasingly become the focus of research and development.

Throughout history, plant products have been successfully exploited as insecticides, insect repellents, and insect antifeedants. Probably the most successful use of plant product as an insecticide is that of the pyrethroids[2]. The insecticidal properties of the several *Chrysanthemum* species were known for centuries in Asia. Even today, powders of the dried flowers of these plants are sold as insecticides. After elucidation of the

chemical structures of the six terpenoid esters (pyrethrins) responsible for the insecticidal activity of these plants, many synthetic analogs have been patented and marketed. Synthetic pyrethroids were preferred because they have better photostability and are generally more active than their natural counterparts.

3.0 FACTORS INFLUENCING DEVELOPMENT OF NATURAL PESTICIDES

Tens of thousands of secondary products of plants have been identified and there are estimates that hundreds of thousands of these compounds exist. There is growing evidence that most of these compounds are involved in the interaction of plants with other species-primarily the defence of the plant from plant pests. Thus, these secondary compounds represent a large reservoir of chemical structures with biological activity. This resource is largely untapped for use as pesticides, however, it takes a while and efforts to establish a viable pesticide especially if one considers the urgency of having one on the market since yesterday.

Unlike compounds synthesised in the laboratory, secondary compounds from plants are virtually guaranteed to have biological activity and that activity is highly likely to function in protecting the producing plant from a pathogen, herbivore, or competitor. Thus, a knowledge of the pests to which the producing plant is resistant may provide useful leads in predicting what pests may be controlled by compounds from a particular species. Isolation and chemical characterisation of the active compounds from plants with strong biological activities can be a major effort compared to synthesising a new synthetic compound. However, the assurance of biological activity and improvement in methods of purification and structural identification is shifting the odds in favour of natural compounds.

Considering the probability of plant secondary products being involved in plant-pest interactions, the strategy of randomly isolating, identifying, and bioassaying these compounds may also be an effective method of pesticide discovery. Biologically active compounds from plants will often have activity against organisms with which the producing plant does not have to cope. Many secondary compounds described in the natural product, pharmacological and chemical ecology literature have not been screened for pesticidal activity. This is due, in part, to the very small amounts of these compounds that have been available for screening.

The discovery process for natural pesticides is more complicated than that for synthetic pesticides. Traditionally, new pesticides have been discovered by synthesis, bioassay, and evaluation If the compound is sufficiently promising, quantitative structure-activity relationship-based synthesis of analogues is used to optimise desirable pesticidal properties. The discovery process with natural compounds is complicated by several factors.

First, the amount of purification initially conducted is a variable for which there is no general rule. Furthermore, secondary compounds are generally isolated in relatively small amounts compared to the amounts of synthesised chemicals available for screening for

2. Are the current harvesting methods effective? Can they be improved to reduce harvesting losses?

3. Are the current handling practices of unprocessed flowers i.e. harvesting, transportation and drying efficient? What needs to be done to improve them?

4. Is the extraction process of pyrethrins effective? Do we know the efficiency of extraction? Is there a way of improving the extraction efficiency? Is the current solvent per unit product optimal? Is the current installed capacity fully utilised? Could the extraction capacity be a bottleneck if we think of sensitising farmers to grow more pyrethrum? Can it be improved?

5. Is the current practice of exporting crude extract for purification cost effective? What needs to be done to purify the crude extract on site so as to minimise the handling charges and thus increase profitability of the operation?

6. Has the product been effectively utilised? This could be looked upon from the perspective of number of products on market. Is there a possibility of expanding the products from the product? What needs to be done to increase the local market base of the product i.e. in form of having more end users?

   Pyrethrum has been mainly applied in insecticide. Different formulations are in the market namely:

   i. Insect spray such as X-Pel. This could be water based or as piperonyl butoxide (PBO).
   ii. Mosquito Coils which could be made in different varieties.
   iii. Mosquito chips (for use in electrical mosquito vaporisers)
   iv. Incense sticks (for repelling mosquito at the same time releasing fragrant incense)
   v. Home & Garden Insect Spray: a non-staining Pyrethrum water-based formulation. For killing aphids, beetles, ants, capsids, flies, mosquitoes, lake flies, fleas, bedbugs, lice, cockroaches, caterpillars, thrips etc.
   vi. Pet Shampoo for killing fleas, ticks, lice, etc. on domestic animals.

7. Are the private entrepreneurs aware of the potential of the plant? Is there a way to sensitise them to invest in the industry?

8. Are the financial institutions aware of the potential of the pyrethrum industry?

9. What are the barriers and incentives on the part of farmers that need to be addressed if we are to realise the full potential of the plant.

The sustainable pyrethrum industry will depend on well articulated intervention strategy that will ensure the communities growing the plant enjoy the benefit accrued from the industry.

5.0 CONCLUSIONS

Pyrethrum is a complex insecticide with the following outstanding properties:

- **Rapid Action:** Pyrethrum is a contact insecticides attacking the nervous system of insects almost immediately and causing knockdown, soon followed by kill.
- **Low Mammalian Toxicity:** No other insecticide can claim such a long record of proven safety towards humans and warm blooded animals. It is one of the least toxic of domestic insecticides available and is rapidly metabolised if accidentally swallowed.
- **Lack of Insect Immunity:** The structure of the molecule is so complex that insect resistance to Pyrethrum is not a practical problem. A very few isolated cases have been reported, unlike synthetic insecticides.
- **Broad Spectrum of Activity:** Because Pyrethrum consists of a group of related compounds, it has a wider spectrum of activity against insect species than many single insecticides. It can be used against any insect found in the house or garden: mosquitoes, flies, cockroaches, aphids, ants etc.
- **Environment friendly - Non resistant:** Pyrethrum is degraded by the combination of sunlight and air and therefore presents little of the hazards which are usually associated with other classes of persistent insecticide. Therefore, it does not accumulate in food chains or groundwater.
- **Repellency:** Pyrethrum is a powerful insect repellent which in combination with its low mammalian toxicity favours it in many applications, such as food and grain storage protection, personal protection (spray-on, roll-on, mosquito coils). Beside repellency, mosquito coils will inhibit target insects from biting.
- **Flushing Action:** Pyrethrum has a much greater flushing effect than any other insecticide; it disturbs pests in their hiding places forcing them to get out and to get exposed to the insecticide.

From a commercial perspective, its major disadvantage is similar to that of "orphan" pyrethrum products are unpatented, produced by small companies, many of them in the Third World. It lacks the sponsorship and a major drive that could make it a major insecticide on the world market. However, the time is right; if proper intervention could be put in place the plant stand a chance of becoming a major forex earner.

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SUMMARY AND CONCLUSIONS

1. Pyrethrum production in Tanzania has been declining over the years from 6000 tons in 1966 to approximately 400 tons in 1999. Among other factors, lack of potential planting materials, poor price and right package to be adopted by farmers have contributed to this decline

2. Changing agricultural policies and roles of different institutions in purchases of pyrethrum at various times had an effect on reducing farmers morale in pyrethrum growing.

3. Pyrethrum research in Tanzania, although started some 40 years ago in the efforts to revamp the pyrethrum production in the country, has not been so effective for the whole of this period. This has been attributed by understaffing, lack of adequate funds and key research facilities.

4. Opportunities to rectify previous mistakes, the present free market economy, availability of expansion land, dedicated managers and farmers gives a possibility of pyrethrum production to increase in the near future

1.0 INRODUCTION

Pyrethrum (Chrysanthemum Cinerariafolium Vis) (now Tanacetum Cineraria folium) is a perennial tropical cross-pollinated plant belonging to the composite family. The plant is cultivated for its flowers, which contain insecticide chemicals known as the pyrethrums.[1] The plant originated from Dalmatian coast of Yugoslavia. Seeds of this plant were brought to Kenya and later to Tanganyika (Now Tanzania) in late 1930's. In Tanganyika Pyrethrum was first introduced in the Northern Regions on the slopes of mount Kilimanjaro and mount Meru. By 1931 thee crop was already in the Southern Highlands of Tanganyika as a cash crop and by 1949 the country was able to export 274 metric tons to the world market (Figure 3) [3,8]. Prior to 1957 production in Tanganyika was almost entirely confined to non-African farms and estates.[1]

In 1960, the Tanganyika government (now Tanzania) decided to establish the Tanganyika Pyrethrum Board (TPB) for the purpose of pyrethrum development and formation of different pyrethrum projects such as construction of pyrethrum processing factory[8] . Apart from this the board was given full autonomy and was mandated:-

- To formulate and give advice to the minister of agriculture on different strategies to develop and protect the pyrethrum crop.
- To receive and advice the minister on how to develop the pyrethrum farmer and hence increase production.
- To advice the crop director on issues regarding giving pyrethrum growing license to farmers.
- To develop, run and finance pyrethrum research.
- To announce the success of pyrethrum development.
- To solicit and ensure good prices for the farmer.

(a) BREEDING

CLONAL SELECTION

In the clonal selection programme a considerable attention has been given to pyrethrum clones with high fresh flower yield, dry matter (DM) content and pyrethrin content of the dry flowers so as to establish their effects and relation to total pyrethrum yield. Breeding work in the late 1950's and early 1960's produced the following clones.

Table 1: The first pyrethrum clones released into the production

CLONE	DM YIELD (KG/HA) (AVERAGE)	PYRETHRIN CONTENT % (AVERAGE)
59/347	500	1.55
59/346	560	1.62
59/351	400	1.87
59/358	450	1.44
60/362	650	1.36

In 1985 the clones in table 2 were released to the Tanzania Pyrethrum Board (TPB) for multiplication and distribution to farmers in altitude ranging from 1800m – 2400m a.s.l.[7]

Table 2: Pyrethrum yield and pyrethrin content for the released clones.

CLONE NO.	(KG/HA)	PYRETHRIN CONTEN %
60/70	700	1.70
65/166	800	1.60
65/194	900	1.50

Other promising lines, which are a result of clonal selection, have shown quite outstanding superiority to the former clones in terms of dry flower yield and pyrethrin content. They can be grown between 1800 – 2600m above sea level in the southern Highlands of Tanzania. However, these clones have not reached the farmer's fields due to lack of a system for rapid multiplication and distribution of clones into large quantities. The characteristics of these improved clones are summarized as follows:-[7,10]

Table 3:

PYRETHRUM CLONE	DM YIELD (KG/HA) MEAN ACROSS FOUR LOCATIONS	PYRETHRIN CONTENT %
78/94	977.1	1.88
79/78	852.5	1.92
79/71	756.4	1.89
78/111	739.3	2.07

In some locations, depending on soil condition and other environmental factors such as rainfall, altitude and temperature the same pyrethrum clones have a potential to give up to 1500 kg/ha of dry flowers.

(a) HYBRIDIZATION:

In a hybridization process using four clones from the selection programme, some of the characteristics of the two crosses are shown in Table 4. Most correlation coefficients between progeny characters were negative.[7,9,12]

Progenies in both populations were uniform and similar in agronomic characteristics. Most of the progeny had a pyrethrin content below that of the parents. Only four plants had a pyrethrum content above 2%. The crossing of clones produced plants with wide variation in the toxin content. Polycrossing might prove better in the future[7,9,10]

Table 4: Evaluation of some characters of progeny lines arising out of two pyrethrum crosses.

Crosses	Flower Stalks	Lateral shoots Stalk	Height (Cm)	Lodging (Scale 0 Min. 5 Max	100 Flowers Weight	Max. pyrethrin Content (%)
60/70X65/166	39.1	5	51.3	1	18.5	2.18
65/194XMporoto local	42.8	6	52.6	1	17.3	2.26

3.0 PYRETHRUM PROPAGATION AND VARIABILITY IN THE FIELD

The conventional propagation of Pyrethrum is through sexual means by seed and asexually through vegetative propagation by split.[1] In Pyrethrum, shortage of planting materials is the most limiting factor to production.[5]

3.1 SPLITS

A split is vegetatively divided plant by mitosis from the mother plant at the base of pyrethrum plant, the plant forms a crown of divisible small plants like tillers starting from the roots. This term "split" is a special term in pyrethrum which is synonymous to tillers in other crops.[1] It denotes the multiplication coefficient of Pyrethrum. Research at Uyole has found most clones to have limited multiplication coefficient of between 10 – 20 splits per plant.[7,12]

The splits are the ones used for field planting. In the field they remain for 3 – 4 moths after planting before flowering.[4] The bulky nature of splits and the logistics involved when one has to plant a large acreage is another factor one has to contend with. This makes the use of splits an expensive, laborious, time and resource consuming exercise.[7] However it is the only method which maintains plantains plant purity in terms of yield and pyrethrum content because they are true to type from the mother plant.[10]

3.2 SEEDS

Pyrethrum is self-sterile, and has to be cross-pollinated to produce viable seeds.[1] Pyrethrum seeds have low germination percentage due to presence of non-viable (unfertilized) seeds. The out crossing – nature of pyrethrum results in seedlings of variable genetic constitutions that vary greatly in their pyrethrin content.[4] Despite the fact that using seeds as propagating material is easier compared to splits, the existence of variability in pyrethrin content in seeds varieties has made breeders switch to vegetatively propagated clones.[3,10]

In view of the above, a continuous research leading to improved flower yield and increased pyrethrin content which is a breeding and agronomy contribution has to be strong within the industry.[10] The use of other modern technological approaches to remove or alleviate some of the production constraints such as shortage of planting materials through invitro – micropropagation of pyrethrum clones must be properly addressed.[2]

4.0 AGRONOMY

Agronomic factors for increased pyrethrum production have been studied. The following are some of the achievements.

4.1 FERTILIZERS

Table 6: Effects of phosphorus and nitrogen on pyrethrum fresh flowers yields (Kgha-1 at two sites)

	UYOLE	IGERI
Control (no. fert.)	3910	2489
20 Kg Pha –1	4330	2594
40 Kgs Pha –1	3496	2064
75 Kg Pha –1	3440	2648
20 Kg Pha –1 + 74 Kg Nha – 1	3192	1618
40 Kg Pha – 1 + 75 Kg Nha – 1	3957	2120
LSD (P. 0 .05)	264	NS

(NS), Not significant.
The main conclusions on this aspect is as follows:-

- The use of phosphate in pyrethrum production is essential if flowers production is to be sustained. Yield increase of between 20 and 40% were observed when phosphate was applied.
- A rate of 40 Kg Pha –1 was found to be optimal for most soil in Njombe and Mbeya districts but smaller rates could be used in more fertile areas.
- Some nitrogen should be applied when phosphorus is used. A rate of 60Kg Nha – 1 in Njombe, less in other areas would suffice.
- Nitrogen should be used in nursery to stimulate the formation of splits, at rate of 80 Kg Nha.

The effect of potassium and micronutrients such as copper, Magnesium, Molybdenum and Boron on yield and pyrethrin content were included in other studies.[7,10]

Application of potassium has no noticeable effect on yield and pyrethrum content[7,10]

- The response to micronutrients was generally inconsistent. In some cases a negative effect was noticed, especially with magnesium. Beneficial effects have been obtained with copper and Molybdenum application in parts of the Southern Highlands where these elements are deficient. The interaction effects that were noted for some micronutrients warrant re-evaluation and quantification, particularly in the case of molybdenum and boron. Difference between clones in their response to micronutrients were negligible. The pyrethrin content in the flowers was unaffected by micronutrients.

Table 7: **Effect of nematode infection on yield (Kg/ Ha) of pyrethrum at Uyole**

	YIELD OF DRY FLOWERS
Healthy plants and clean soil	1152.7
Healthy plants and infested soil	1146.1
Infected plants and uninfested soil	970.5
Infected plants and infested soil	928'5
LSD (P –0.5)	75.1
CV (%)	4

4.4 THE FOLLOWING FINDINGS WERE ALSO STUDIED FOR THE INCREASED PYRETHRUM PRODUCTION.

Weeding in pyrethrum is a laborious activity, which needs attention as labour availability is constantly decreasing. To alleviate this situation combination of technologies had to be found. An alternative method is to use herbicides.[7,10] In a study at Uyole it has been shown that Galex x 500EC at 0.6 -0.7 La.i./ha, Gesagard 500FW at 1.75 – 2.5La.i/ha and sencor (metribuzin) 70 WP at 0.52 – 0.6 Kg a.i./ha can be used for broad leaf and some grass weed control in pyrethrum production without detrimental effect to the crop in terms of pyrethrum flower yield and pyrethrum content. However, for stubborn, noxious weeds as combination of hand weeding and herbicides will make complete weed control for all growing seasons.

Study on inter-cropping technique in pyrethrum production for medium altitude (1700 – 1800m above sea level) was made between pyrethrum and beans (Passels vulgavis L.)[7] Depending on farm conditions such as land pressure, markets and choices in an area, pyrethrum and beans can be grown as companion crops without detrimental inter species competition especially for non-trailing bean varieties.

Pyrethrum or beans when grown individually, as pure stand give more yield that when these two crops are inter-cropped. However the monetary value per unit area is more in the inter-crop practice. The best crop spacing mixture for pyrethrum and beans which give farmers profit and good utilization of land was found to be 60cm x 30 cm for pyrethrum and 30cm for beans giving a land equivalent ration (LER) of 1.40.

4.5 LOSSES DURING STORAGE AND MARKETING

Studies on storage have shown that the pyrethrum of the flowers tends to decrease with time after picking.[5] Storage conditions and the containers used for the dried flowers affect this loss. The results from storage trial at Uyole[7,10] are shown in figure 3. The loss of 3% pyrethrum per month is considerable, and at current prices could easily amount to a 40% loss in earnings. Delays in extraction arise from any one of several causes such as delays in delivering the flowers from the farm to the buying center during the peak farming season, problems at buying centers, lack of transport, cooperative or private buyer procedures and priorities.[5] For small holders this results in pyrethrum production becoming un economic.

4.6 PYRETHRUM PRODUCTS UTILIZATION

Farmers in the Southern Highlands zone have been using fresh pyrethrum leaves to control maize stalk borers in their maize farms for quite a long time. The leaves are simply crushed or squeezed and the liquid material is applied on the funnel of the maize plant.[7]

Some research work on the use of pyrethrum marc or grist as botanical insecticide in the field and in storage of maize and beans has been done by collaborative efforts between pyrethrum research plant protection and post harvest research programmes.[7] A non governmental organization (NGO), known as Hifadhi ya Mazingira (HIMA), in collaboration with Uyole is now working with farmers in Iringa region in Tanzania through on-farm trials (see table 8). About 200 to 500 maize farmers around Uyole research institute have been using pyrethrum marc fir 3 years to control maize stalk borer.[7] The results are quite encouraging. However refining the application methodology is needed.

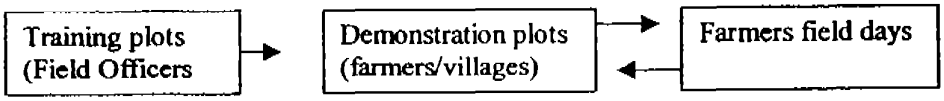
Some farmers are using pyrethrum marc or grist to control cutworms in crops such as cabbage, tomatoes and onions. Livestock keepers leaving around the pyrethrum factory benefit by using freely pyrethrum marc to deworm their animals.

Table 8: Crop protection using pyrethrum materials in the field and store.

FIELD			
Pyrethrum Material	Application rate	Crop	Insect to be controlled
Crushed fresh Pyrethrum	20-25Kg into 20 liters of water	Maize	Maize stalk borer
Pyrethrum Marc	25-30Kg Ha-1 (0.06% W/W) Pyrethrum	Maize	Maize stalk borer
Storage			
Pyrethrum grist	1000gm of grist for 100kg of maize or beans	Maize Beans	Maize grain Weevils and Bean bruchids

4.7 TECHOLOGY TRANSFER

Output FROM Research to farmers are transpired through demonstration plots. The pyrethrum demonstration plot programmer which existed in 1975 to 1979 involved three step:-[10]



The training plots were equal to demonstration plots but were being used as "training plots" for the field officer. The training was supervised by staff from District Agricultural Office and staff from the research institute – Uyole in Mbeya. This system helped much to transfer different technologies developed from research. This system no longer exists in pyrethrum production. An effective research – extension linkage should be established for the research findings to reach the farmer.

4.1.7 FUNDING FLOW AND STAFF POSITION

For the last 37 years, operational research funds came from the Tanzania Government, Nordic countries, World Bank and FINNIDA Organization. Consistent funding was rare and inadequate to maintain experimental trials. For instance between 1987 and 1999 in total, the research budget requirement from the different source was 142 million Tshs. (USD 0.18m at current exchange rate). Only 10% of this was obtained.[7]

Inadequate staffing has negatively affected pyrethrum research programmes. There is need to consolidate pyrethrum paramount research (Appendix 1).

5.0 PYRETHRUM PRODUCTION TREND

The pyrethrum production trend[8] since 1949 is summarized in Table 9. Appendix 2 and figure 1 and 2.

Table 9: Total Tanzania production of dried flowers with distribution in tons and percentage between Northern areas and Southern Highlands (in Metric tons) 1949 –1974 (Jespersen, 1974).[4]

GROWING SEASON	TOTAL PRODUCTION	PRODUCTION NORTH	PRODUCTION SOUTH	% AGE FROM SOUTH
1949-50	274	91	183	67
1950-51	298	147	151	51

1951-52	330	165	165	50
1952-53	270	126	146	53
1953-54	286	137	149	52
1954-55	691	454	237	34
1955-56	616	386	230	37
1956-57	779	489	290	37
1957-58	695	433	262	38
1958-59	608	368	240	39
1959-60	880	556	324	37
1960-61	1132	582	550	49
1961-62	1466	520	946	65
1962-63	2299	1010	1289	66
1963-64	2317	671	1646	71
1964-65	2948	953	1765	68
1965-66	4160	961	3199	77
1966-67	6015	1023	4992	83
1967-68	5216	1014	4202	81
1968-69	4842	708	4134	85
1969-70	2416	373	2043	85
1970-71	2666	287	2379	89
1971-72	4276	438	3838	90
1972-73	4016	316	3655	91
1973-74	3282	427	2855	87

Where North means, Arusha & Kilimanjaro regions
Where South means, Iringa and Mbeya regions.

5.1 PYRETHRUM PRODUCTION BEFORE 1960

In Tanzania, commercial pyrethrum cultivation began in the 1930's to 1957 on large farms and estates owned by European or Asian Settlers in west Kilimanjaro and Arusha, and in the southern Highlands regions particularly in Mbeya and Iringa. In General Pyrethrum cultivation increased steadily in the Southern region. All pyrethrum dry flowers were transported to Kenya where there was an Extraction plant.[6]

5.2 PRODUCTION BETWEEN 1960 TO 2000

After 1960 Africans began to grow the crop in small plots up to 0.4ha. The farmers were encouraged by the free distribution of planting material and the provision of extension and marketing services.[7] Thus production of dried flowers expanded from 2,300 tons in 1963 to over 6,000 tons in 1967.

Pyrethrum cultivation continued to increase-more in the south rather than in the Northern regions due to availability of land in the south as compared to the Northern regions.[8] At least six regions in the country are engaged in pyrethrum production namely Arusha, Kilimanjaro, Rukwa and Ruvuma. The country became the second largest producer of pyrethrum in the world next to Kenya which is now the leading producer.

The production trend between 1967/68 and 1998/99 show the decline of flowers from around 5000 tons to nearly 500 tons. The situation was critical between 1990/91 and 1991/92 when production was below 1000 tones (Appendix 2).[11]

Pyrethrum production in five years fell from 2500 tones to 600 tones in the years between 1992/93 and 1996/97. This sharp decline was caused by farmers refusal to release their flowers on credit and others abandoning the production of pyrethrum altogether.[11]

5.3 Main reasons for the decline in Pyrethrum Production:-

(a) Low Prices offered to farmers as a result of poor world market[11]

In the 1970's/1980's and 19990's the world external market for pyrethrum dropped drastically due to many countries switching to synthetic pyrethroids which were cheaper than pyrethrins. This led to unattractive prices offered to farmers.

(b) **Introduction of competitive crops with attractive revenues**

Pyrethrum production has been facing stiff competition from other food and cash crops. (crops such as cabbage, Maize, round potatoes and in the suburbs, horticultural crops, such as tomatoes have taken up the land.[15,16,17] For instance in the Mbeya suburban areas, once pyrethrum areas, have now changed to intensive agriculture of horticultural crops.

In the 90Km stretch from Nombe to Kipengere mountains, Iringa region, the area has been replaced by maize and round potatoes. The Eastern part of Mufindi district, Iringa region, is now planted with tea, maize and round potatoes.[14]

(c) **Change in the farming systems**

Areas such as the Uporoto-Umalila highlands situated at 1700 – 2000m above sea level, in Mbeya region show a change in the farming system. [15, 16, 17] Diagnostic survey and participatory rural appraisal done by (Kirway 1988, Nalitolela 1990, Kiara, 1995 and Mussei 1998 indicated a complete change of the farming system in areas which once had potential for pyrethrum growing, the reports show an increase from 45 people per square km to 62 people per square km by the year 2000. Thus population growth is causing land pressure and acreage decrease per person by 2% annually.

As a result farmers grow many crops in a continuously subdivided land. The dominant crops are Pyrethrum, Maize, beans, peas, wheat, sweet potatoes, round potatoes, millet and recently, coffee. [15, 16]

Some farmers have introduced intercropping between Pyrethrum and maize or beans, while others in parts of Ileje and Umalila in Mbeya region practice annual cropping whereby pyrethrum is allowed to flower one season only instead of the recommended 3 years before uprooting.

5.4 YIELDS AND PYRETHRIN CONTENT

Experience has shown that pyrethrum will come into full flower production in the second and third year and that production rapidly declines thereafter. In view of the soil pulverizing effect of the crop and the hazards of "root knot nematodes" it is necessary to uproot every third year, and to rotate with either a grain crop or a period of fallow.[10] Flower picking is 9 –10 months at an interval of 10 – 14 days. Cutting back of dead flower stocks is done annually, either at the onset of long rains, or immediately after the long rains.

According to a survey of small holders carried out in 1974, the average annual yield of dried flowers per ha was 260kgs[4] Since then estimation has shown than yields have been falling, as a result of adverse climatic conditions and because of aging of plants in the absence of replanting. Current average annual yields for a farmer are put at 200kg per ha, with yields of 100kg 9n the first year and 250kgs in both the second and third years. The optimum yield should be 500 – 800kgs/ha.[14]

The pyrethrum content of dried flowers, which is measured prior to processing, depends on the quality of the planting material, climatic conditions altitude and the efficiency of drying and marketing operations.[10] For over a period of sixteen years 1962/63 – 19977/78 Pyrethrum content remained fairly stable around an average of about 1.20%. (see table 10).

Table 10: Average overall Pyrethrum Contents (%) 1962 – 1978

YEAR	CONTENT %
1962-63	1.29
1963-64	1.24
1964-65	1.28
1965-66	1.30
1966-67	1.23
1967-68	1.22
1968-69	1.18
1969-70	1.22
1970-71	1.26
1971-72	1.23
1972-73	1.21
1973-74	1.21
1974-75	1.17
1975-76	1.15
1976-77	1.11
1977-78	1.10

However, sample survey of 933 farmers carried out from 1979 to 1987 had a pyrethrum content between 1.3 and 1.69%. This trend reflects the absence of improved planting material in the fields, and lack of quick flower transportation to the factory.[7]
Also, it reflects individual farmers are able to dry properly their flowers and to maintain the good flower quality needed. But when the produce is mixed either bad flowers the overall pyrethrum content during extraction goes down.[5]

5.5 EFFORTS TO RAISE PYRETHRUM PRODUCTION

The Tanzania Government, under National Agricultural Development Program (NADP 1 & 11) planned to raise pyrethrum production from 3,000 tons in 1973/74 to 14,000 tons by year 1983/84. The Northern Pyrethrum factory in the North (Tanganyika Extract Company) whose capacity was to extract 6,500 tons/Annum could not cope with the targeted increase in production.[14] A new factory (which became operational in 1980s) with a capacity of 4,500 tons was constructed in the South, Mafinga – Iringa region where expansion programmer of pyrethrum production was concentrated due to availability of land and labour.

The European Economic Union (EEC) and the World Bank funded pyrethrum development programmes between 1978/79 and 1984/85. The programmes concentrated on:-[18]

(a) Research and training
(b) Bulking centers for multiplication of clonal materials
(c) Seed farms and nurseries for production of seeds and seedlings
(d) Improvement of infrastructure – roads and bridges.
(e) Improvement of pyrethrum drying

5.6 (A) BULKING CENTRES

In an effort to ensure enough good planting clones to growers, Tanzania Pyrethrum Board (TPB) under the financial assistance from the World Bank Project (1980 – 1985) established about nine bulking centers all over the growing areas. Eight of them were in the Southern Highlands while the Northern region had one bulking center.

In the bulking centres, selection for high yielding clones was being carried out. The selected clones and sometimes clones from research were being multiplied further at TPB's farmers before finally distributing them to farmers. These

nurseries were organized and run by TPB. In every bulking center an Assistant Production Officer (APO) was employed . They were successful in faster dissemination of good pyrethrum plants to farmers. However, the bulking centres were expensive to manage and when the World Bank and EEC (1978 – 1985) left funding, the multiplication centers collapsed to date.

5.6 (B) PRODUCTION OF SEED AND SEEDLINGS

TPB had seed farms at wattle company – Njombe, Dabaga – Iringa, Ilindi –Mbeya and at Mafinga – Iringa. EEC sponsored training for field officers at Uyole (Mbeya) so as to make TPB self sufficient in field staffs. They also became non-functional to date after the EEC assistance was withdrawn.[18]

5.6 (C) IMPROVEMENT OF INFRASTRUCTURE AND GODOWNS

The World Bank offered assistance for the rehabilitation of feeder roads and bridges in the pyrethrum growing areas so as to make transportation of pyrethrum flowers during rainy periods possible. The World Bank constructed storage godowns for storing pyrethrum briefly before they were delivered to the factory for processing.[18]

5.6 (D) FARM SERVICES CENTRES

TPB established farm services centers in pyrethrum areas. Various goods especially building materials were availed. Tractors were given on hire. The goods and services were given on credit bases and payments were deducted during the sales of pyrethrum. To some extent this assistance stimulated pyrethrum production.[18]

5.7 (E) FLOWER PICKING AND DRYING

Flower picking and drying is labour Intensive and expensive. It remains to be family labour. Today many youths have migrated to towns and flower picking is left to the old people. This aspect has an impact on the cultivation/expansion of pyrethrum.

Drying of pyrethrum flowers after picking is essential. Moisture content must be reduced from 80% to 10% and making minimum loss of dry

matter and pyrethrins which are heat sensitive and vulnerable to oxidation. Quick drying with minimum heat is desirable. Many farmers use sun drying on mats or bare ground. Some use wire mesh raised above ground. Where there is limited sunshine hours and prolonged wet weather, natural drying is difficult. In such area farmers dry pyrethrum in kitchen over the cooling fire.

A programme was initiated to make 400 portable box driers which were given on loan to farmers, thus reducing the frying time from 12 days to 10 hours or less.[18] Drought forced central barn driers were constructed in some places. The artificial drying was constrained by scarcity of fuel fire wood and the global environmental concern at present on deforestation. Solar driers were tried but the initial costs proved high. Attempts were made by EEC (1982/84) to buy wet flowers in place of dry flowers. This system was disliked by farmers due to price changes.[19]

Farmers were paid 25% to a kilogram of wet flowers compared to the price of a kilogram of dry flowers. Also the wet flowers never received second payments.

5.0 INSTITUTIONAL PYRETHRUM PURCHASES INVOLVEMENT

Between 1930 – 1960, all pyrethrum dry flowers were transported by settlers/farmers to Kenya where an extraction plant existed.6 In 1964/65 the Tanganyika Extract company (TECO) which was contracted at Arusha in Tanzania bought all pyrethrum flowers from farmers. In 1970's Regional Cooperative Unions took over the purchases and delivered to TECO. In early1980's Tanganyika Pyrethrum Board (TPB) was the only buyer of all flowers until the late 1980's when co-operative unions were allowed again to buy pyrethrum. TBP and co-operative Union continued the purchases until the middle of the 1990's when TPB was privatized in 1998. All commercial activities of pyrethrum viz. procurement, processing and export was taken over by Tanzania pyrethrum Processing and marketing Company Limited (TPPMCL), an affiliate of a South African Firm known as International Chemicals Producers.

The Pyrethrum market liberalization policy has allowed private companies to purchase the crop from farmers as agents of TPPMCL which processes the flowers into crude extract. This free market economy is likely to improve the marketing system from the hither-to changeable marketing structure of the crop. The Tanzania pyrethrum Board (TPB) at present remains as a Government regulatory body on issues pertaining to Pyrethrum. Other roles of TPB now are to fund research and supervise extension services[11]

6.1 MAJOR BOTTLENECKS AND CONSTRAINTS ON PYRETHRUM PROMOTION

7.1 RESEARCH

The main constraints on pyrethrum research are lack of:- continuity, competent staff, research facilitates, adequate funds, transport facilities and professional training.[7]

7.2 PYRETHRUM PRODUCER PRICE

The producer price in pyrethrum has been unattractive for many years.[7] The producer price per kg received in 17 years from 19980/81 to 1996/97 was between Tshs. 6.50 and Tshs 300/= per kg, less than one USD from 1997 to 2000 the price has been increased to Tshs. 350/=. The price offered is for Grade V. Few farmers qualify for grades 1V – 1 and hence do not get bonuses or second payment.

7.3 LACK OF PLANTING MATERIALS

Since the closure of the bulking centers and seed farms it has been difficult to get enough planting materials to farmers of high yielding clones with high pyrethrin content.[18]

7.4 POOR EXTENSION SERVICES

Farmers are inadequately assisted in carrying out proper agronomical practices and good crop husbandry.

7.5 DRYING FACILITIES

Farmers depend on sun drying which is very unreliable in many places as a result of which most pyrethrum flowers rot. This is the main reason why many farmers have small plots of roughly 0.4 hectares per household.

7.6 INSTITUTIONALIZED MARKETING SYSTEM OF PYRETHRUM

Farmers for many years have not had the chance to control the pyrethrum market. Rather, institutions dictated both the marketing and the prices.[11]

7.7 DETERIORATION OF SOILS AND SOIL-BORNE DISEASES

Pyrethrum plants are heavy feeders. Pyrethrum cultivation is done mainly in uplands on undulating lands. Soils are not conserved and are washed away by rains. Combined with the fact that pyrethrum plants feed heavily without replacement of nutrients most pyrethrum farms are deteriorated and infertile. Old pyrethrum fields have yet another problem for accumulating soil borne diseases caused by Nematodes.[12]

8.0 FUTURE PLAN AND RECOMMENDATION FOR REVAMPING PYRETHRUM PRODUCTION IN TANZANIA

Key areas to be considered for reviving pyrethrum production in Tanzania are as follows:-

8.1 RESEARCH

Efforts should be directed towards improving Research Technology backed up by motivated staff, modern equipment including tissue culture and adequate funding.

8.2 PLANTING MATERIALS

Provision of improved planting materials to replace the old materials developed in 1950s, 1960s, and 1970s. Bulking centers and seed farms should be revitalized at District council level.

8.3 IMPROVED MARKETING SYSTEM

It is necessary to improve marketing system in the free market economy backed up by active primary societies or pyrethrum Growers Associations. Farmers will be motivate through better prices and availability of inputs on loan.

8.4 IMPROVED DRYING FACILITIES

In order to get better quality flowers with high pyrethrum content appropriate artificial driers should be designed and given on credit to pyrethrum farmers.

8.5 EXTENSION SERVICES AND LAND MANAGEMENT

Soil conservation is important in all pyrethrum fields since mast of them are in the uplands. Good extension workers should be at the farmers disposal to guide them on good crop husbandry practices, control of diseases, and soil management .

8.6 The future of pyrethrum is bright ; and when all the bottlenecks explained in the foregoing are checked the production may pick up to 3,00 – 4,000 within the next few years (2003 – 2005).

APPENDIX 1: PYRETHRUM RESEARCH STAFF POSITION (1973 – 2000)

YEARS						
Qualification	1973-78	1979-83	1984-88	1989-93	1994-98	1999-20
Post-graduate (Breeder)	0	0	1*	0	0	0
Post graduate (Agronomy)	1*	1*	1	1	1	1
Graduate	1*	0	0	1	I	1
Diploma	0	0	1	1	2	2
Certificate	1	0	2	0	0	0
Auxiliary staff	2	3	4	2	2*	O

Notes

- Table shows staff on full time pyrethrum research work
- * means the staff was not available all the time of 5 years

Appendix 2:

PYRETHRUM PRODUCTION BY REGION (TONS) 1965/66 – 1999/2000

	YEAR	IRINGA	MBEYA	NORTHERN ZONE	TOTAL
	1965/66	2163	1063	961	4187
	1966/67	2836	1956	1228	6020
	1967/68	2864	1338	1014	5216
	1968/69	1247	1387	708	3342
	1969/70	1279	764	373	2416
	19970/71	1484	960	288	2732
	1971/72	2333	1505	438	4276
	1972/73	2364	1291	361	4016
	1973/74	1904	951	425	3250
	1974/75	2244	2060	437	4741
	1975/76	2130	1130	506	3766
	1976/77	1918	1029	388	3335
	1977/78	1730	643	173	2546
	1978/79	1125	430	78	1603
	1979/80	963	637	25	1624
	1980/81	1213	430	59	1702
	1981/82	1108	722	69	1899
	1982/83	1234	535	32	1601
	1983/84	950	469	20	1439
	1984/85	981	580	21	1582
	1985/86	848	491	12	1351
	1986/87	706	513	12	1231
	1987/88	804	599	5	1408
	1988/89	744	559	8	1589
	1989/90	799	782	8	1589
	1990/91	671	1017	17	1705
	1991/92	914	1598	43	2555
	1992/93	700	1741	69	2500
	1993/94	45	424	41	500
	1994/95	124	436	40	600
	1995/96	250	355	5	610
	1996/97	300	288	12	600
	1997/98	-	-	-	480
	1998/99	-	-	-	600
	1999/2000	-	-	-	1000

** Estimate

1. Actual tonnage collected at the factory in 1997/98 was 137.46
2. Actual tonnage collected for 1998/99 season was 317.8

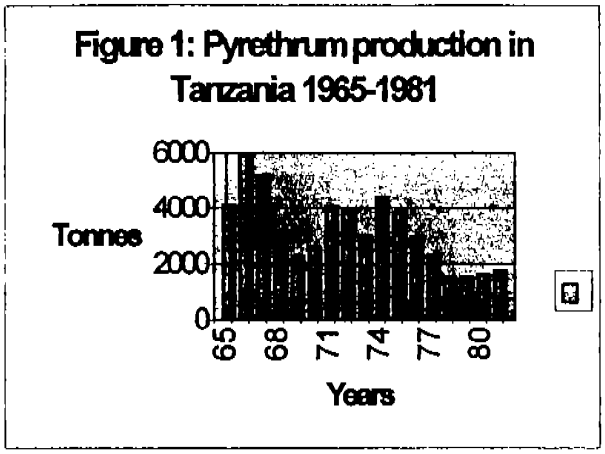


Figure 1: Pyrethrum production in Tanzania 1965-1981
6000
4000
2000
0
Tonnes
65
68
71
74
77
80
Years

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INTERNATIONAL CENTRE FOR SCIENCE
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Industrial Processing of Pyrethrum in Tanzania

Paper presented at the ICS-UNIDO Workshop
On Industrial Utilization of Pyrethrum
At Sheraton Dar-es-Salaam Hotel, Tanzania
29-30 May, 2000

By
Mr. W. J. Swai

INDUSTRIAL PROCESSING OF PYRETHRUM IN TANZANIA TECHNICAL PAPER BEING PRESENTED IN THE WORKSHOP ON INDUSTRIAL UTILIZATION OF PYRETHRUM 29 – 30 MAY, 2000-SHERATON HOTEL

l INRODUCTION

PYRETHRINS – A naturally occurring insecticidal agent found in the flowers of chrysanthemum cinerariaefolium is the world's most used botanical insecticide. Considered the safest insecticide because it is almost non-toxic to warm blooded mammals while being highly toxic to a wide range of insects. Pyrethrins decomposes when exposed to light leaving no residual effect, thus rendering the atmosphere and its surroundings free from hazardous pollution; a very significant advantage over other insecticides such as D.D.T

Technologies for obtaining pyrethrins from flowers are varied. Widely used are conventional methods which employ organic solvents to leach flowers. A recently pioneered process uses liquid Carbon dioxide (C02). It is claimed to be cost effective and yields a pale, transparent, solvent free concentrate of pyrethrins in one step.

Industrial processing of pyrethrum in Tanzania can be traced back to 1960's. Tanzania's first pyrethrum processing plant was established in Arusha, Northern Tanzania under the company name of Tanganyika extract company Limited (TECO) and began operating in 1962. Pyrethrum was extracted in pot extractor using N-Hexane as solvent to produce a concentrate pyrethrum oleoresin and a by-product marc. Products traded are listed as pyrethrum extract, pyrethrum dried marc, pyrethrum powder and pyrethrum marc powder. The plant had a nominal capacity of 6000 metric tonnes per annum of dried pyrethrum flowers.

During 1970's, in response to changing circumstances in the pyrethrum industry, it was felt that TECO plant may not be in a position to process all flowers and another extraction plant may have to be installed in Southern Highlands of Tanzania where 70% of the total production of flowers was being cultivated. As a result of feasibility studies undertaken by a mission sent from FAO Investment Centre in Rome and later on updated by a consulting firm Dalgety Associates, new extraction facilities were installed at Mafinga in Iringa Region, Southern Tanzania. The new plant with a capacity of processing 4,500 metric tonnes of dried pyrethrum flowers in a year with a stream efficiency of 250 days and operating on 3 shifts went into commercial production in April, 1982.

The status of today is such that the TECO Arusha plant has been brought to a safe shutdown and possibly a permanent one. The main reason for this closure is associated with a low production of pyrethrum flowers in Arusha Region with a declining trend from 1966/67. It is then the purpose of this paper to discuss the processing technology as obtaining at the only existing and active pyrethrum factory in Tanzania located at Mafinga, Iringa Region.

2.0 THE COMPANY/OWNERSHIP

The plant operates under the company name of Tanzania Pyrethrum Processing and Marketing Co. Ltd. (TPPMCL). Ownership has changed hands from a government managed parastatal organization to a private managed company. It was on 6 February, 1998 that new company TPPMCL was officially handed over (sold) to M/S International Chemical Producers (ICP) of the republic of South Africa under a privatization programme of the Government of Tanzania.

3.0 MANUFACTURING PROCESS

3.1 *GENERAL DESCRIPTION OF PROCESS*

The process is the solvent extraction of the insecticidally active pyrethrins from dried flower heads of the chrysanthemum cinerariaefolium to produce a crude concentrate pyrethrum extract and a by-product pyrethrum dry marc.

The dried pyrethrum flowers are milled into "grist" and the grist is mixed with solvent (Normal Hexane) to get "miscella" . The miscella is evaporated under vacuum to get "pyrethrum crude extract", the required semi-finished product. In the process of leaching to get miscella, "pyrethrum marc" is left which is the by-product of the extraction process.

Production of the crude pyrethrum extract and pyrethrum dry marc is summarily shown in the flow diagram and process block diagram appended. The main unit operations and the different process stages are described below.

3.1 *DETAILED DESCRIPTION OF PROCESS*:

3.2.1 *Flower Reception and Storage*

The raw material for the plant is pyrethrum flowers dried to an average moisture content of 10-12% by weight. The active pyrethrums should amount to 1.3%. The dry flowers coming to the plant are taken in from the farmers. They are weighed, sampled and an antioxidant of food grade (Normal Butyrate Hydroxyl Toluene-BHT) is added at a rate of 0.4 kg per tonne of dried flowers. Following sampling and addition of the BHT, flowers are pneumatically conveyed to the vertical flower storage silos.

3.2.2 MILLING

The milling plant takes in whole flowers from the storage silos and turns out ground flowers of a particles size suitable for solvent extraction.

The mill, is a hammer mill fitted with screens with 2 mm perforations. The grist from this mill is fed to a grist classifier fitted with 500 micron sieves. Grist which passes the sieves is conveyed to a grist storage bin; the oversize is re-cycled back. The object is to produce a grist with as even a particle size as possible and as near to 500 micron as can be achieved. In any event not more than 5 – 10% of the grist should pass a 250 micron sieve.

3.2.3 EXTRACTION

The extraction plant consists of pot extractors, tanks, evaporators, pumps desolventisers, heat exchangers, refrigeration unit and ancillary equipment to carry out the solvent extraction of gristed dried pyrethrum flowers.

The grist is charged into extractors batch wise. There are ten pot extractors all inter-connected and piped so that solvent of miscella can be pumped from the bottom of the one into top of the next one or from the bottom of the end one back into the top of the first one. The order of charging with grist and the direction of pumping with solvent is such as to allow counter-current percolation with the solvent. In this way the freshest grist is being extracted with miscella from the previous extractor longest in process is being washed with clean solvent from the process tanks.

At any one time the extraction operation is carried out with six extractors connected in series. The remaining four are in various stages of solvent drainage, de-solventizing, or emptying, cleaning and re-charging.

After passing through the extraction vessels containing grist, the solvent is now rich in pyrethrins and other hexane solubles. It contains approximately 4% of total solubles at this stage and is pumped to one of two intermediate settling tanks where it's allowed to stand in order to precipitate any entrained fines or water particles. This intermediary solution is called MISCELLA.

3.2.4 EVAPORATION

Following settling, the miscella is transferred to solvent stripping or evaporation system. Solvent stripping takes place in two stages. In the first sage a falling film evaporator operating under reduced pressure removes the bulk of the solvent. In the second stage the last traces of solvent are removed under high vacuum in a thin film evaporator.

The N/Hexane vapor leaving the two evaporators is condensed and recirculated in the process. Following final solvent stripping the concentrated extract is the

product "pyrethrum crude extract" containing approximately 30% of the insecticidally active natural pyrethrins. The stuff is pumped from the process block or extraction area to extract storage and handling building.

3.2.5 FINISHED PRODUCT HANDLING/STORAGE

The crude extract from the process block is pumped directly into security tanks from where it is drained into a scale tank for weighing once per day. After weighing extract is drained into mixing vessels where it is blended into a homogeneous lot for each batch. Following blending extract is packed into lacquered drums prior to shipment from the factory.
Purchasers often refine this extract for use in the manufacture of aerosols and household sprays.

3.2.6 BY PRODUCT HANDLING/STORAGE

Following the leaching of all pyrethrins from the grist, the first extractor (exhausted) in the series is disconnected. Solvent is drained from the extractor by gravity and re-circulated into the process. Following this drainage the last traces of solvent are removed from the extraction vessel. The steam evaporates all remaining solvent; the steam and solvent vapor are condensed and the mixture of the water solvent passed through a separator, the solvent returning to the process and the water to waste.

Following removal of the last traces of solvent from the exhausted grist, the spent material or marc is discharged from the extraction vessel through a bottom man way into a hopper cum chain draglink conveyor. From this the wet marc passes into a pneumatic drying and conveying system to a fluidized bed dryer. The fluidized bed dryer removes the last traces of moisture from the marc which is the fed to storage silos.

The by-product "pyrethrum dry marc" is handled in either of two ways. Bagging prior to shipment from the factory or used as boiler fuel.

By-product marc contains only traces of pyrethrins (0.05-0.8% $^{w}/_{w}$) but does, however, contain about 12% protein. It is used for making mosquito coil and employed as a livestock feed. Other applications include its use as a crop protect ant (control of maize stock borers and other crop dudus) and as a farm manure especially when wet and semi-decomposed.

4.0 PLANT EFICIENCY (PYRETHRUM) RECOVERY

In any pyrethrum plant a high pyrethrins recovery is essential. The pyrethrins recovery is expressed as a percentage and is calculated by:

$$\frac{\text{Weight of pyrethrins in product} \times 100\%}{\text{Weight of pyrethrins in feed}}$$

With both feed and product pyrethrum content being determined by the AOAC 9th Edition Method of analysis.

Recovery at TPPMCL factory currently lies between 85 and 90 per cent.

The plant design guaranteed a pyrethrum recovery of 94.% w/w min. from flowers of 1.30% pyrethrins or better.

Plant efficiency increases with increase in pyrethrins content of the feed. As such farmers are encouraged to supply high-quality flowers.

5.0 CONCLUSION

We are thankful to ICS-UNIDO for having organized a useful workshop like this and given our company an opportunity to present a paper. We look forward for such workshops/seminars to be organized by UNIDO in the future.

INTERNATIONAL CENTRE FOR SCIENCE
AND HIGH TECHNOLOGY

Utilisation of Pyrethrum in Industry, Kenya Paper

Paper presented at the ICS-UNIDO Workshop
On Industrial Utilization of Pyrethrum
At Sheraton Dar-es-Salaam Hotel, Tanzania
29-30 May, 2000

By
Mr. R. K. Shah

UTILISATION OF PYRETHRUM IN INDUSTRY

I. INTRODUCTION

Man realised the need to control the growth of harmful insects, long before the dawn of civilisation. He needed to protect:

- Himself
- His crops
- His food stores, and
- His animals

To achieve this, a suitabnle insecticide has to be used. Suitability here refers to:-

- High degree of Biological efficacy.
- Low impact on the environment.
- Low danger or risk arising from its use to non-target insect species and Animals.
- Low mammalian toxicity.

The active ingredient used is therefore of primary concern. In this regard, Pyrethrum stands head and shoulders above all other available actives in terms of safety and toxicity. It is therefore the ideal choice of active ingredient for insecticide manufacturers, and to the end users of household insecticides.

The insecticide used has also to be appropriately formulated and packaged for ease of use and handling. The types of formulations currently available include:

- Aerosols
- Powders
- Emulsifiable concentrates
- Vapour mats
- Mosquito coils

II. PYRETHRUM AS A RAW MATERIAL

The primary products of pyrethrum processing, that are made available to formulators and manufacturers are:

1. Pyrethrum extract

This is the product of solvent extraction of dried pyrethrum flowers. It is available either as a highly refined concentrate commonly referred to as Pale extract, or as a semi-refined concentrate, referred to as Oleoresin. Standardised extracts contain 25 or 50% pyrethrins.

Uses
The pale extract is used in the manufacture of various high value products. These include:

Aerosols.
The East African market alone currently stands at seven million cans per year. Unfortunately, 70 to 80 percent of thse contain synthetic chemicals as active ingredient.

Emulsifiable concentrates.
These include Home & Garden Sprays and Pet Shampoos. 50% of the Pet Shampoos used in Europe and America are formulated using Pyrethrum due to its low mammalian toxicity.

Powders.
The Pyrethrum extract is impregnated onto carrier material to produce an insecticidal powder for use against crawling insects. Since these powders are used within our dwelling and eating places, the low mammalian toxicity of Pyrethrum is astrong plus point.

Vapour mats.
This is a relatively new concept in terms of its operation, where the active ingredient source is impregnated onto a cellulose mat, and then dispensed into the air by application of low heat to it.

2. Pyrethrum Powder
This product also known as mosquito coil powder, is obtained by pulverising the dried pyrethrum flowers into a fine powder, which is subsequently standardised to a predetermined active ingredient content.
This powder is predominantly used to manufacture Mosquito coils, which is perhaps the most widely used domestic insecticide, in the coastal and lake regions of Africa and South East Asian countries.

3. Pyrethrum Marc
This is a by-product of solvent extraction undertaken to produce Pyrethrum extract. The product has a very low content of pyrethrins and is therefore used as filler material in the manufacture of Mosquito coils.
Pyrethrum marc is also used in the control of storage pests such as weevils and as cattle feed. It has been found to contain a high level of digestible crude protein.

MARKETING OF PYRETHRUM BASED PRODUCTS

The local market is centered on mosquito coils since they are readily available in all areas, are relatively cheap and have been proven effective in keeping away the most revered insect pest in this region – mosquitoes. Products such as aerosols, vermin powder and vapour mats are predominantly used in middle and upper class homesteads.

Our company exports besides supplying our local market, exports mosquito coils to Tanzania, Uganda, Sudan, Zimbabwe, Malawi and even Japan. It is however, difficult to penetrate the American and European markets owing to high cost of obtaining registration of finished products.

Almost all of the pyrethrum extract produced in the region is exported to America and Europe. Their demand actually surpasses our current production levels. The extract is used in formulating products such as pet shampoos and aerosols, which due to high level of environmental and safety awareness, are very popular.

The idea situation here would be to supply them with finished products.

There is a huge influx of importd products into the East African region from all over the world. These products are formulated using synthetic materials active ingredients, and are relatively cheaper than locally manufactured products, owing to the lower costs of production in the source countries.

INTERNATIONAL CENTRE FOR SCIENCE
AND HIGH TECHNOLOGY

Marketing of Pyrethrum in Tanzania

Paper presented at the ICS-UNIDO Workshop
On Industrial Utilization of Pyrethrum
At Sheraton Dar-es-Salaam Hotel, Tanzania
29-30 May, 2000

By
Mr. Edward J. Materu

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INRODUCTION

Pyrethrum the plant Chrysanthemum cinerariaefolium was first introduced to the East African Region in the late 1920s and early 1930s. Pioneers of Pyrethrum growing in Kenya enthusiastically organized growing of the crop, forming the Kenya Pyrethrum Growers Association in the early 1930s and with several legislations being passed ensuring careful inspection and grading, and quality maintenance, licenses were issued to planters and the entire origination and marketing was kept under tight control.

In Tanzania, then Tanganyika, an ordinance was passed by the legislative assembly to create the Tanganyika Pyrethrum Board (TPB) in 1939 which operated on similar lines with the Kenyans.

The TPB issued licenses to growers, advised farmers on the good crop husbandry through agricultural extension services.

In Kenya and in Northern Tanzania Pyrethrum was grown largely on estates up to the mid 1960s and from the late 1960s small plot holders of between 20 acres to 10 acres of land began growing pyrethrum.

Today in Tanzania there are approximately 20,000 families involved in pyrethrum growing a total of 8,000 acres.

Until 1998, all Pyrethrum activities starting from the supply seeds and seedlings to the farmer, procurement of pyrethrum dried flowers, processing and marketing of its products were undertaken by the Tanganyika Pyrethrum Board (TPB). With the advert of privatization of the parastatals in Tanzania however, the commercial activities of the Board were diversified and are now in the hands of a private firm. TPB was left with regulatory functions.

WORLD PRODUCTION OF PYRETHRUM AND PRICES FOR PYRETHRUM PRODUCTS

World production of Pyrethrum is normally measured in metric tons of dry flowers and pyrethrins content. The pyrethrum content varies from 0.8% to over 2%. Table I summarizes the amounts produced in the leading growing countries in the late 60s and earl 70s. At present, the world's leading producers are, Kenya, Tanzania, Tasmania in Australia, Rwanda, with smaller amounts being grown in Papua New Guinea, Ecuador and India, Uganda is also joining the club.

Most of these countries export over 80% of their produce, largely in the form of crude extract. Of the producer countries mentioned, only Kenya and Rwanda have refineries wherein they can produce refined pyrethrum extract, a high value product.

Apart from the export of crude pyrethrum extract and the refined product suitable for direct inclusion in aerosols, most of the producer countries also export ground flowers for the world's mosquito coil market.

World production in 1967/68 was approximately 2500 tons in excess of demand. During this period, because of the existence of unsold stock coupled with the considerable publicity on the development of synthetic pyrethroids led to a general decline in world production during the next 3-4 years. History has it that there is a general 10 years cycle in pyrethrum peak and low seasons.

The United States of America is the largest importer of pyrethrum products world wide and they have very stringent regulation on imports to that country. With stronger USA governmental action against persistent insecticides that were alleged to pollute the environment and harmful to humans and mammals the Environmental Protection Agency (EPA) mandated that all stake holders in the industry be required to obtain clearance from them before any product is exported to the U.S.A. The requirement of the exporter was to obtain a label from the EPA in the U.S.A. a label which was obtained after the exporter had availed to the EPA in the USA. An analysis of solvents etc. used in the extraction process. The analyses are carried out in various scientific and research stations in the U.S.A. The cost involved in carrying out these researches is borne by the merchants involved in the pyrethrum industry.

TABLE 1

Comparative Pyrethrum Production figures of Different countries During 1967 – 1972 World wide (metric tons).

Country	1967 – 1968	1968 – 1969	1969 - 1970	1970 - 1971	1971 - 1972
Kenya	11,059	7,300	5,909	9,747	14,400
Tanzania	5,102	4,757	2,416	2,665	4,300
Ecuador	1,609	1,744	1,457	1,241	1,100
Japan	950	838	700	600	380
Rwanda	120	200	640	800	1,000
Others	700	620	600	580	600
Total	19,540	15,459	11,722	15,633	21,780

TABLE 11

Pyrethrum Production in Tanzania by Region (tons) 1973 – 1995

YEAR	IRINGA	MBEYA	NORTHERN ZONE	TOTAL
1972/73	2364	1291	361	4016
1973/74	1904	951	425	3280
1974/75	2244	2060	437	4741
1975/76	2130	1130	506	3766
1976/77	1918	1029	388	3335
1977/78	1730	643	173	2546
1978/79	1125	430	78	1603
1979/80	962	637	25	1624

1980/81	1213	430	59	1702
1981/82	1108	722	69	1899
1982/83	1234	535	32	1601
1983/84	950	469	20	1439
1984/85	981	580	21	1582
1985/86	848	491	12	1351
1986/87	706	513	12	1231
1987/88	804	599	5	1408
1988/89	744	559	8	1311
1989/90	799	782	8	1589
1990/91	671	1017	17	1705
1991/92	914	1598	43	2555
1992/93	700	1741	69	2500
1993/94	45	424	41	500
1994/95	124	436	40	600

TABLE 111
Pyrethrum product in Tanzania by Region (Tons) 1996 – 1999

YEAR	IRINGA	MBEYA	NORHERN ZONE	TOTAL
1995/96	250	355	5	610
1996/97	300	288	15	600
1997/98	-	-	-	480 1
1998/99	-	-	-	600 2**
1999/2000	-	-	-	1000 **

** Estimates
1. Actual tonnage collected at the factory in was 137.46
2. Actual tonnage collected for 1998/99 season was 317.08

Currently, the worlds demand for pyrethrum stands at 20,000 metric tons of dried pyrethrum flowers per year. At 20,000 mt. World demand the target has not been reached. Shifting trends to organic and Natural Insecticides predicts that the world demands is bound to increase.

Looking at table 11 and 111, production figures for Tanzania show an irreversible downward trend from the mid 1970s to the present date except for a short period in 1991/92 – 1992/93.

There are a number of factors which affected production in Tanzania. In the mind 1970's villagization programmer initiated in Tanzania where by whole populations were moved to live in new collectivized areas affected production especially in the Southern Highland Regions of the country, urban migration and low prices paid to farmers also contributed to the low production. Many countries also switched to synthetic pyrethroids which were cheaper to produce than natural pyrethrins.

Historically, extremes of climate in the East African Region also has a bearing on agricultural production. In Tanzania every 10 years or so there is some serious drought and a less serious one every 3 to 5 years.

Although in the pyrethrum growing highlands, drought may not be an important factor, food crops will be more attractive to cultivate in view of the ready market and higher prices offered during the drought period.

During the 1960's the farmer was paid shs. 0.50 for a 1b of dried flower equivalent to Shs 1.10 per kg. In the 1970s the farmer was paid shs. 5.40 for a kilo of dried pyrethrum flowers.

In the 1980s same farmer was paid between shs. 12.00 to 29.00 per kilo for a kilo of dried pyrethrum flowers and today the farmer is paid Tshs. 350.00.

Table 111 Shows production in Tanzania for the year 1996 – 1999. The figures are frighteningly low to say the least. Apart from the Elnino phenomenon which devastated many areas of agricultural production, cold weather which persisted in the northern hemisphere for longer period even during the summer there by inhibiting the breeding of insects meant very little sales to those areas.

At the same time TPB was under divestiture by the government. Regular publicity of the exercise frightened farmers as the were not sure where they will sell their crop. We are hopefully making a new turn now.

PRODUCTION AND PRICES OF PYRETHRUM PRODUCTS IN TANZANIA.

Until the 1970's the bulk of pyrethrum production in Tanzania was in the northern highlands of Arusha and Kilimanjaro Regions. The other producing Regions were Iringa and Mbeya in the Southern Highlands of Tanzania.

A processing Extract Co. Ltd. (TECO) was privately owned and processed the pyrethrum flowers through solvent extraction process thereby producing crude extract. The factory had an installed capacity to process up to 6,000 tones of dried pyrethrum flowers. A separate milling plant was also built to grind pyrethrum dried flowers into pyrethrum powder for the mosquito coil market.

Prior to 1960, all pyrethrum flowers produced in Tanzania were baled and sold/exported to Kenya. The procurement of dry pyrethrum flowers was organized through the cooperative unions. The Tanganyika Extract Co. had representatives working with the unions to undertake procurement of flowers and transporting the flowers to the factory in Arusha. This was the arrangement until 1974 when the factory was nationalised. From 1976 the Tanganyika Pyrethrum Board took over all procurement activities and marketing of the pyrethrum products at the Arusha factory. Concurrent with this, a new factory was built in the Southern Highlands Region of Tanzania, at Mafinga in Iringa Region. The factory was duly commissioned in 1982.

The factory with a capacity to process 4500 metric tons of dry pyrethrum flowers, was conceived in the mid 1970's to operate together with the Arusha factory in view of the anticipated increase in production. It was envisaged then that production would have reached approximately 14,000 mt.by mid – 1980's. As it turned out, production slackened instead of going up. With the advent of low price paid to the farmer and the farmer not being paid on the spot, they turned into alternative crops mainly Irish potatoes which fetched better prices and was less laborious.

In Tanzania, all flowers are procured dry and are collected in jute gunny bags of 30 kgs. Where they are transported to the factory. Every individual farmer is licensed and allocated a license number. This is done because of the quality of their flowers i.e. pyrethrins content in the flowers. Recycling of the gunny bags is also usually undertaken i.e. The gunny bags are sent back to the cooperative unions for re-use. Payment to farmers is on spot at the collection centers. Such payment is regarded as 1st payment to the farmer. Once the flowers are received at the factory and analyses carried out to determine pyrethrins content in the flowers which in turn is also verified by the importer, 2nd payment is then effected to the farmer calculated on the basis of pyrethrins content of the flowers . **Appendix 1** shows prices offered to farmers for different grades of pyrethrins content in different seasons. Products produced and marketed by the Tanganyika Pyrethrum Board are as follows:

1. Pyrethrum Extract - Concentrate.
2. Pyrethrum Extract – Standard 25% w/w Pyrethrins
3. Super fine Pyrethrum Powder. 1.3% or 0.6%
4. Pyrethrum Dried Marc.

Appendix 11 is an illustration of products produced and marketed by the Tanganyika Pyrethrum Board.

Appendix 111 shows sales of pyrethrum crude extract and dry marc for the period 1981 – 1999.

A. Approximately 98% of the Pyrethrum Extract concentrate is exported to the U.S.A.
Parking is in steel drums of 100 kgs (net) 50 kgs and 25 kgs.
The lack of refining in Tanzania denies the country from a wider spectrum of the market in which our neighbors in Kenya and Rwanda reap from the sale of high value product.

B. The Pyrethrum extract standard 25% w/w is in effect the concentrate material diluted in kerosene and marketed locally in small quantities to the needy for application in farm sprays by ultra low volumes (ULV) techniques.

C. Superfine pyrethrum powder is exported to Japan and the Far East. A substantial volume is also sold locally to the mosquito coil industries.

D. Dry pyrethrum Marc is also exported, but a larger potion is marketed locally mainly to ranches. An appropriate mix of dry Mark and maize bran has proven to be a good cattle feed. The small pyrethrum residue contained in the dry marc helps in deforming of the cattle.
It is also apparent that a good number of farmers in the vicinity if the pyrethrum factory use the marc to fight stalk borer in maize.

As mentioned earlier, the U.S.A. is the largest user of pyrethrum products. Because of the chemical nature of the product, the merchants i.e. the exporters to the U.S.A. and the importers in the U.S.A. are required by law to conform to certain regulations in order to remain marketing pyrethrum products in the US market.
The Environmental Protection Agency (E.P.A) in the U.S proposed a labeling requirement for all pyrethrum products entering the U.S. market.

This was initiated as a measure to safeguard the consumer from using chemicals that are harmful to humans and domesticated animals. The Chemical that are harmful to humans and domesticated animals. The chemical Specialties Manufactures Association (CSMA) in the USA with other key players in the pyrethrum to the EPA. The fees contributed by each key players ranged from the high of US$ 100,000 per annum to US$ 38,000 currently.

The current players in the task force are:-

1. Aventis: Environmental Science U.S.A./Europe.
2. Botanical Resources Australia – Tasmania
3. S.C. Johnson & Sons Incorporated – Racine.
4. McLanghlin Gormley King co. Minneapolis U.S.A.
5. OPYRWA –Rwanda
6. Prentiss Incorporated U.S.A
7. Pyrethrum Board of Kenya
8. Tanzania Pyrethrum Board/Tanzania Pyrethrum Processing & Marketing Co.

Pyrethrum products are marketed through negotiations between the buyer and seller. In East Africa, the pyrethrum producers Kenya, Tanzania and Rwanda have formed a club in which they meet regularly to exchange notes on production in RWATAKE member countries and prices to the farmer and market situation in general. The club known as RWATAKE standing for Rwanda, Tanzania and Kenya also discusses on competing synthetic pyrethyroids and other natural pyrethyroids.

It may be noted that at the moment research on "Neem" material obtained from plant extractives of a tree with a similar name which has a knockdown effect on insects is gaining momentum and this can add pressure on pyrethrum.

These and others are subjects discussed at the RWATAKE meetings. Problem for Tanzania is that the other two producers/processors i.e. Kenya & Rwanda have an edge over Tanzania in that they own refineries and therefore enjoy a wider spectrum of the world marker. Tanzania efforts to establish a refinery began in the late 1970's, but due to lack of funds the refinery was never built.

In Tanzania, the only known formulator producer of aerosol which is pyrethrum based is a private company Mansoor Daya chemical Ltd. Based in DSM. Because of lack of refined pyrethrum material in Tanzania , Mansoor Daya Chemical buys crude pyrethrum Extract from TPB now TPPMCL –exports it to owners of refineries in Kenya or the United Kingdom for refining and re-imports the refined material ready for formulation.

Two other private companies in Tanzania are involved in the manufacture of mosquito coils which are pyrethrum based.

Dawa ya Mbu Ltd. Based in Dar es Salaam is still active in this business and Africa Flowers Industries in Moshi was until the early 1990's in the mosquito coil manufacturing business. They have shut down since then.

PYRETHRUM AND THE ENVIRONMENT – THE TANZANIAN EXPERIENCE

Pesticides are heavily used in the agricultural sector in Tanzania including animal health for control of ticks, tsetseflies and a small percentage in public health programmers including mosquito control to curb the spread of malaria and control of flies etc to improve sanitation.

The main categories of pesticides used in Tanzania are insecticides, fungicides and herbicides. Insecticides are used widely in farm agricultural produce.

Several of the pesticides currently being used in our country are banned o severely restricted in many countries in the world.

The Journalist Environmental Association of Tanzania (JET)* in 1993, with the assistance of 'Swiss aid Tanzania' commissioned the Department of chemistry at the University of Dar es Salaam to examine the extent of DDT use and hazardous pesticides in use in the country.

JET discovered that accessing information on pesticides, particularly on their importation distribution and use in Tanzania is extremely difficult. However Jet's research had revealed without doubt that DDT is being imported, formulated and distributed for sale and use to farmers thought Tanzania. This is happening despite the fact that DDT was declared restricted substance in Tanzania 1990. A two year grace period was granted to dispose of surplus stocks and in 1993 DDT was banned all together.

Farmers are unaware of the long term environmental hazards of DDT not to mention the dangers of not wearing protective gear when applying pesticides.

There is need to publicize the safer alternatives to DDT not offering special education programmer to the users.
Available information so far on pyrethrum is that no health hazards are associated with it. It does not depress cholinesterase or induce other harmful actions on mammals. It deteriorates so rapidly there is no residue.

MARKETING CONSTRAINTS OF PYRETHRUM PRODUCTS

The following may cited as constraints in the marketing of pyrethrum products.

- Labeling requirement by the EPA in the U.S.A
- The high fees payable to the steering committee/task force
- The lack of refining facilities in Tanzania – only one known formulator of pyrethrum based aerosol is available in the country
- Although a member of the East African grouping of RWATAKE – Tanzania contributes very little to the "Pyrethrum Post" a scientific and research magazine produce quarterly.

Following change in policy by the government on investments to the country and having regard to the fact that the commercial activities under pyrethrum are now privatized, this should be the opportune time to expand not only the growing of pyrethrum but also invite investors to invest in a refinery, aerosol manufacturing industries etc.

Researchers could also take the opportunity following the expanded market to research in the wider use of pyrethrum marc for control of stalk borer in maize already exhibited by farmers in the vicinity of the factory.

Pyrethrum Extract is a natural product derived from chrysanthemum flowers which has been used safely and effectively as an insecticide for centuries.

Tanzania is endowed with vast arable land where pyrethrum will flourish. With the prevailing economic climate and good governance coupled with willing researchers there is every possibility for Tanzania and the East African Region in particular to abandon the dangerous chemicals now in use for the known safer natural chemical in the not too distant future.

It can be done play your part.

PAPER BY:

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Tanganyika Pyrethrum Board,
Rump assets under the
Presidential Parastatal Sector Commission

Price structure for the purchase of dried pyrethrum flowers for selected years/seasons

1983/84 SEASON

Grade 1 Py. Content above 1.4%	Shs.	18/50
Grade 11 Py. Content 1.30 – 1.39%	Shs.	16/80
Grade 111 Py. Content 1.20 – 1.29%	Shs.	15/40
Grade 1V Py. Content 1.00 – 1.19%	Shs.	14/50
Grade V Py. Content below 1.10%	Shs.	12/60

1984/85 SEASON

Grade 1 Py. Content above 1.4%	Shs.	29.90
Grade 11 Py. Content 1.30 – 1.39%	Shs.	23.50
Grade 111 Py. Content 1.20 –1.29%	Shs.	21.60
Grade 1V Py. Content 1.00 – 1.19%	Shs.	19.60
Grade V Py. Content below 1.10%	Shs.	17.60

1986/87 SEASON

Grade 1 Py. Content above 1.4%	Shs.	43.30
Grade 11 Py. Content 1.30 – 1.39%	Shs.	29.40
Grade 111 Py. Content 1.20 - 1.29%	Shs.	36.20
Grade 1V Py. Content 1.00 – 1.19%	Shs.	32.80
Grade V Py. Content below 1.10%	Shs.	29.50

1996/97 SEASON

Grade 1 Py. Content above 1.4%	Shs.	*
Grade 11 Py. Cotent 1.30 – 1.39%	Shs.	*
Grade 111 Py. Content 1.20 – 1.29%	Shs.	*
Grade 1V Py. 1.10 – 1.19%	Shs.	*
Grade V Py. Content below 1.10%	Shs.	300/=

1999/2000SEASON

Grade 1 Py. Content above 1.4%	Shs.	
Grade 11 Py. Content 1.30 – 1.39%	Shs.	
Grade 111 Py. Content 1.20 – 1.29%	Shs.	
Grade 1V Py. Content 1.10 – 1.19%	Shs.	
Grade V Py. Content below 1.10%	Shs.	350/=

*Not available

Appendix 11

1. "AFRISECT"PYRETHRUM EXTRACT – O/R CONCENTRATE

Specification: Physical Properties:

Appearance: Dark brown viscous liquid with minute clear spherical bubbles which emulsified on constant stirring.

Colors: Dark brown

Odors: Pleasant aroma with minimal pungency

Specific Gravity: 0.975 approximately at room temperature (av. 25.2^{0}C)

Flash Point : Above 100^{0}F. (av. 110. 38^{0}F)

Solubility :
- (a) Solution in kerosene giving bright yellow solution
- (b) Very sparing soluble in cold water, forming an emulsion
- (c) Sparing soluble in cold water, giving increased formation of oily spherical droplets
- (d) Very soluble in most organic solvents and oils etc. forming clear bright yellow solutions

Freon insoluble: Trace

Volatility: Less than 3% on average

Chemical Properties: Total Pyrethrum: 28% w/w. – 32% w/w. pyrethrins.

Acidity: Mildly acidic, pH 5.7 approximately i.e. within the range of 5.5 – 5.8.

Miscellaneous: Other components present in very small quantities are fatty acids, hydroxyl and non hydroxyl carotenoids, chlorophylls, alkenes etc.

Standard Specification: Total Pyrethrins: 25% w/w + 0.5%

Application: Total Pyrethrins: The product in its form has no use. But on refining, the dew axed, decolorized and stabilized concentrate is widely used due to its non toxicity to human beings and its high efficiency and rapid knock-down effect on a wide range of flying insects and other household pests such as flies, cockroaches, bugs, fleas etc. Addition of synergists, mainly piperonyl but oxide, increases the toxicity and retains the paralytic effect of the inspected.

(b) 95% passing through 100 B.S. Mesh sieve, i.e. the particles have a size of approx. 152. Mill microns. The company can supply powders of 100 Mesh or 200 Mesh depending on the customers specification and requirements.

Application: Pest Control e.g. bugs, fleas etc. Crop insecticide For control, of crop pests as a Crop Protestant. Mixture with pyrethrum marc, at correct proportions and other additives to modify burning, perfume etc, becomes useful for manufacture of mosquito coils.

4. PYRETHRUM DRIED MARC

Specification: Physical properties:

Appearance: Dark brown with yellowish tinge and coarse powder.

Odour: Rather sweetish odors

Moisture Content: Less than 5%

Particle size: 1/16"approximately

Chemical Properties:

Total pyrethrins: 0.06% w/w to 0.08% w/w pyrethrins

Application: In the manufacture of mosquito coils in which the pyrethrum dried with marc in ground to a fine powder and mixed with finely ground pyrethrum powder and other additives such as malachite green and other organic fillers. Cattle feed ingredients, whose content of protein (13%) is near that of wheat brains. Used as farm manure, especially when wet

5. **PYRETHRUM MARC POWDER**

Specification: Physical Properties:

Appearance: Co lour:	Dark brown/yellow powder
Adour:	Rather sweetish smelling powder
Moisture content:	Less than 5%
Particle size:	100 or 200 B.S.Mesh depending on customer's requirements
Chemical Properties:	
Total Pyrethrins:	0.06% w/w pyrethrum approximately.
Application:	In mosquito coils, especially when mixed with pyrethrum powder.

Appendix 111

TANZANIA PYRETHRUM BOARD

SALES PERFOMANCE REPORT OF CRUDE EXTRACT & DRY MARC
FROM 1981 – 1999 APRIL

YEAR	CRUDE EXTRACT	DRY MARC
	KGS	TONS
1981/82	3,395.44	102.83
1982/83	44,701.47	1,101.48
1983/84	31,909.5	1,151.29
1984/85	45,218.85	1,151.29
1985/86	33,248.25	833.84
1986/87	38,925.85	972.28
1987/88	44,640.75	1,020.28
1988/89	39,981.55	974.24
1989/90	48,801.0	785.7
1990/91	48,648.73	505.92
1991/92	58,194.48	465.56
1992/93	38,345.5	438.73
1993/94	26,007.0	308.92
1994/95	24,610.0	152.52
1995/96	16,227.0	1.68
1996/97	4,250.0	-
1997/98	3,815.0	-
1998/99	12,800.0	-
TOTAL	563,700.37	9,966.56

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INTERNATIONAL CENTRE FOR SCIENCE
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Production of Pyrethrum in Rwanda

Paper presented at the ICS-UNIDO Workshop
On Industrial Utilization of Pyrethrum
At Sheraton Dar-es-Salaam Hotel, Tanzania
29-30 May, 2000

By
Mr. Sylvain Nzabagamba

Workshop on Industrial utilization of Pyrethrum in RWANDA

Production of Pyrethrum in RWANDA

The pyrethrum has been introduced in RWANDA after the Second World War by the Belgian colons in the northern regions of RWANDA, along the volcanous chain.

In 1963 the government of Rwanda became interested by that new cash crop and ordered to local authorities to seek for lands and extend the pyrethrum cultivation.

In 1968 a planters cooperative (ASPY) concerned with pyrethrum was born and a processing organization based on pyrethrum Extraction plant (USINEX) built in1972. Before this date, Rwanda exported in RDC or Kenya the baled dried flowers. It is advisable to note that this had been provided by (UNDP) Programmer des Nations Unites pour le Development with the financial assistance of the European Development Fund (EFD).

The period of 1972 to 1977 was one of sustained high yields of production with1174 tons in 1972; 1427 in 1973; 1301 in1974; 1753 in 1975; 1500 in1976 and 1136 in1997.

In order to promote and strengthen the increase in production the government of Rwanda decided May 1978 to fuse the two entities existing ASPY & USINEX, in one unique entity named OPYRWA (Office du Pyrethrum au Rwanda). The first project undertaken by OPYRWA was to build a refinery. This was ordered from the Australian Company VEW in 1978. The decision of buying the refinery from the Australian Company VEW ,supported by UNIDO, alienated OPYRWA's most important costumer, Mclaughlin Gormely King (MGK), who took most of Rwanda's crop from 1974-1977 but none in 1978-1979.

From 1978 to 1981 the pyrethrum production fell in the following order:
935 tons in 1978; 772 in 1979; 938 in 1980 and 955 in 1981. After two years VEW finally admitted that they could not get the refinery to work. In the meantime, a shortage of natural pyrethrum had developed and the price for the crude Extract increased in 1980. OPYRWA was unable to benefit from that price because the Extract was kept with intention of putting it through the refinery and when a decision to sell was finally taken it was too late and demand and prices had fallen.

From 1982 to 1984 the flowers production increased; going from 1087 tons in 1982; 1218 in 1983 to 1149 in 1984. In the meantime, further problems arose in 1983 when new evaporators were ordered for Extraction plant, but a dispute over the contract resulted in a refusal by the supplier to install the new apparatus. The result was that a complete year's production was lost.
From 1985 to 1989, the production refills due to a very poor sales situation. It went from 786 tons in 1985; 586 in 1986; 499 in 1987; 582 in 1988 and 790 in 1989. The poor sales situation led to a very unfavorable exclusive distributorship signed with

Briddle Sawyer a trading Company who simply resold the Extract to the main buyers, MGK FAC, SC Johnson wax and Prentiss.
The sales contract was unfair in that Briddle Sawyer had complete freedom to accept or reject OPYRWA's Extract, whereas OPYRWA could not sell to any other customer and the price offered was extremely low.

In late 1985 Mitchell Cotts, a British Company took on the job for refurbishing the refinery and completely redesigned the process.

From the day that Mitchell Cotts Staff left OPYRWA, the process failed to produce any saleable pale Extract because the OPYRWA's Technicians were not well trained. In spite of this, refinery was accepted and Mitchell Cotts declined to accept further responsibility. By late 1986 OPYRWA was bankrupt. Sales achieved at an uneconomic price because of the monopolistic exclusive Sales agreement with Briddle Sawyer. The morale in the office was at its lowest level. The farmers had not been paid for a year and in consequence, flower production dropped to 586 tons of dried flowers. Much good clonal material had been uprooted and all agronomic research abandoned.

In March 1987 the government decided to cut its losses with OPYRWA, but first sent the Auditors, who revealed serious errors in the management. They gave detailed proposals for reduction of overheads and improved procedures. Legal action was taken against various individuals and suppliers and most of recommendations adopted. The result has been a remarkable turnaround for OPYRWA. Although flowers deliveries actually fell in the first twelve months, this was largely due to a shortage of planting material, but increased in 1990 until 1993, despite the war which arose since October 1990.

In the period of 1994 until 1998 the pyrethrum production was practically nil. This is due to the tragic events of genocide in 1994 and the insecurity, which arose from 1996 to 1998. OPYRWA could survive by the stock of crude extract realized in 1992 and 1993. This has been sold to AGREVO and P.B.K. during the period after the war. Since 1999, OPYRWA is focusing all its efforts to relaunch the pyrethrum production by collecting some clonal material and installing nurseries. OPYRWA has set up some incentive measures to the farmers by increasing the price and maintaining nearby the growers a reinforced team of agronomists in order to keep the interest of the growers for pyrethrum cultivation. In this respect OPYRWA calls upon all pyrethrum producers and particularly UNIDO for a sustained assistance in Rwanda. This assistance will consist of:
-Selection of clones of high-yield strains, multiply them and distribute them to the growers.
-Rehabilitation of drying areas and the factory.

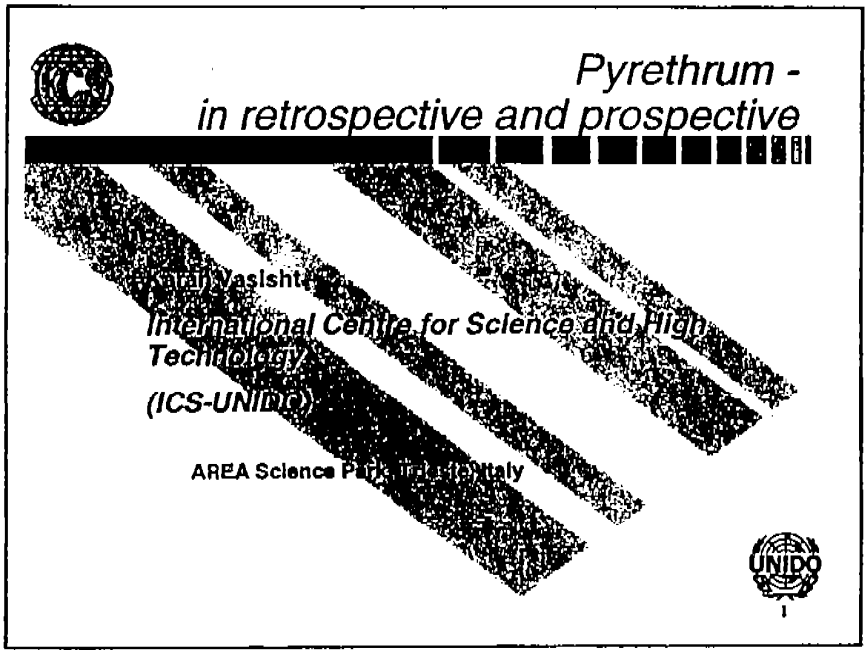
By: Sylvain Nzabagamba

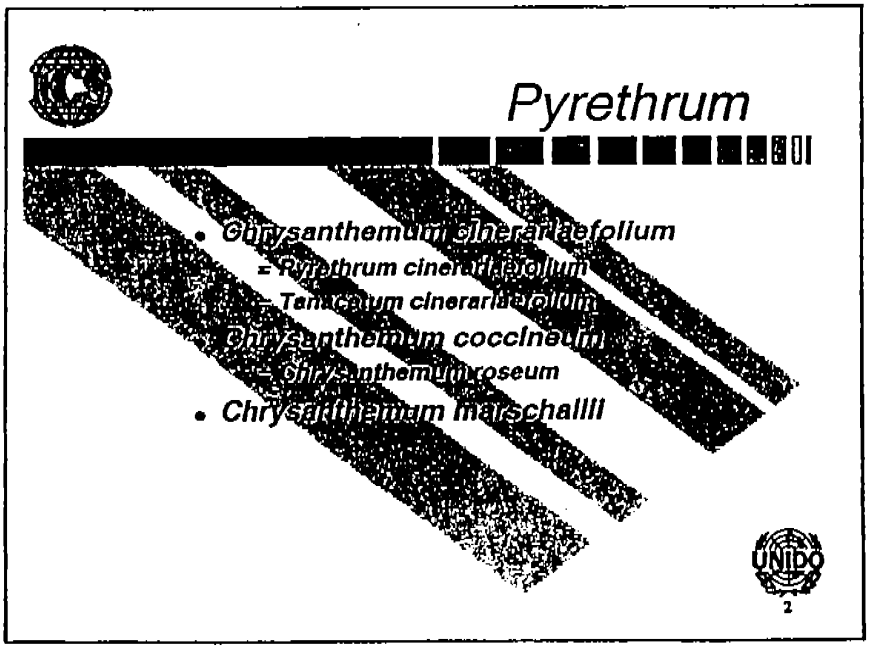
INTERNATIONAL CENTRE FOR SCIENCE
AND HIGH TECHNOLOGY

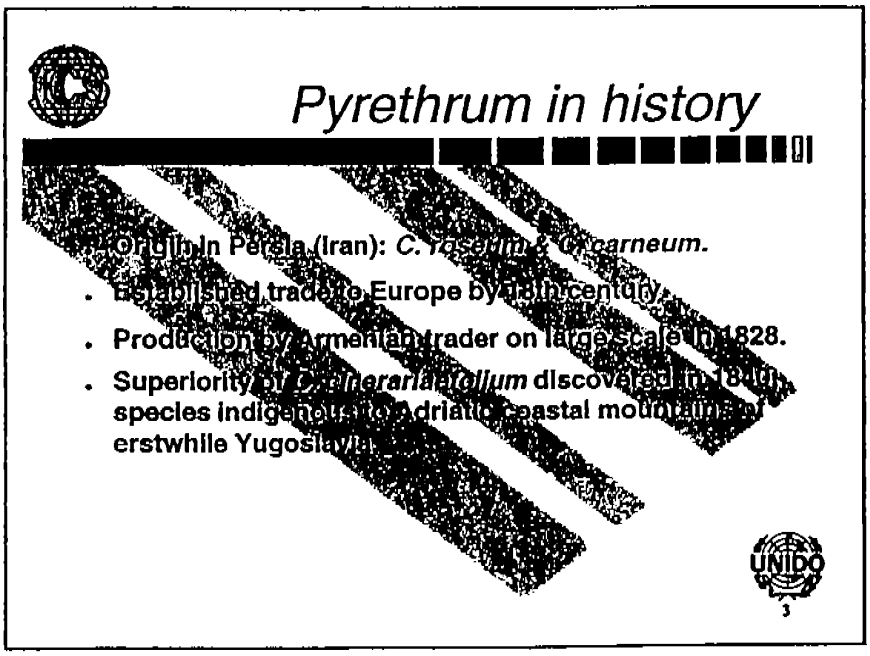
Pyrethrum – in retrospective and prospective

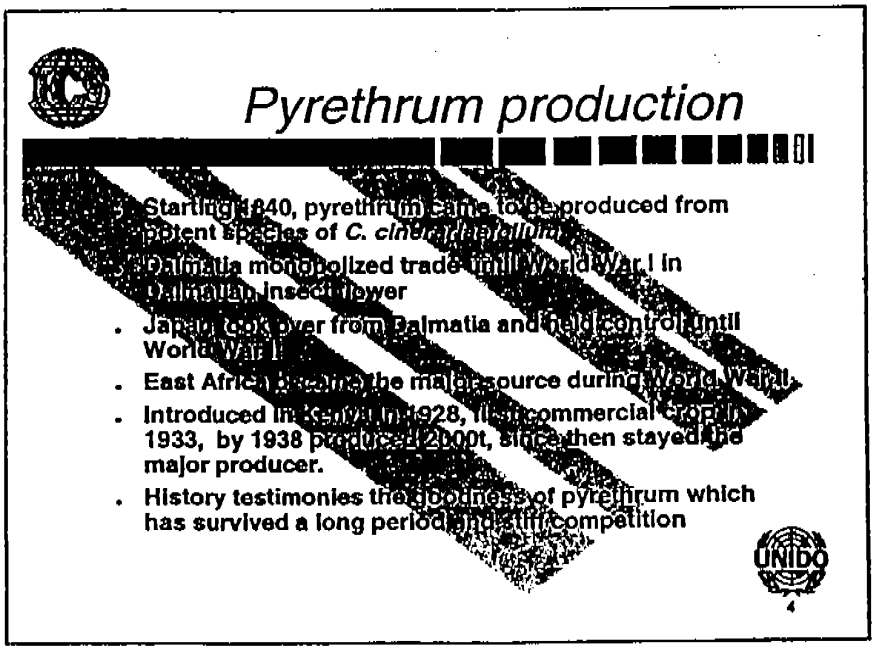
Paper presented at the ICS-UNIDO Workshop
On Industrial Utilization of Pyrethrum
At Sheraton Dar-es-Salaam Hotel, Tanzania
29-30 May, 2000

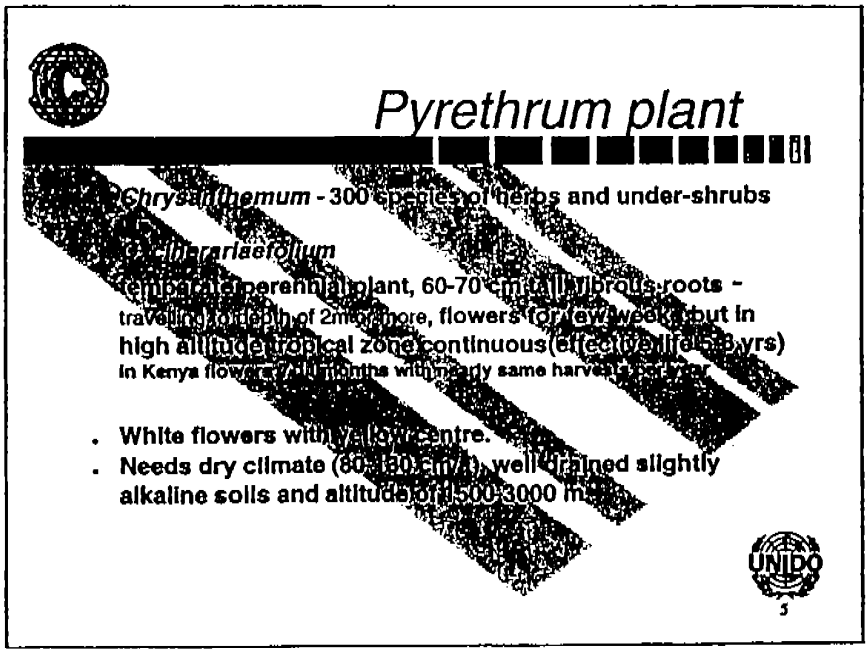
By
Dr. Karan Vasisht


Pyrethrum -
in retrospective and prospective
International Centre for Science and High Technology
(ICS-UNIDO)
AREA Science Park
Italy
UNIDO
1


Pyrethrum
• Chrysanthemum cinerariaefolium
= Pyrethrum cinerariifolium
= Tanacetum cinerariaefolium
• Chrysanthemum coccineum
= Chrysanthemum roseum
• Chrysanthemum marschallii
UNIDO
2


Pyrethrum in history
Origin in Persia (Iran): C. roseum & C. carneum.
Established trade to Europe by 18th century.
Production by Armenian trader on large scale in 1828.
Superiority of C. cinerariaefolium discovered in 1840's, species indigenous to Adriatic coastal mountains of erstwhile Yugoslavia.
UNIDO
3


Pyrethrum production
Starting 1840, pyrethrum came to be produced from potent species of C. cinerariaefolium.
Dalmatia monopolized trade until World War I in Dalmatian insect flower
Japan took over from Dalmatia and held control until World War II
East Africa became the major source during World War II.
Introduced in Kenya in 1928, first commercial crop in 1933, by 1938 produced 12,000t, since then stayed the major producer.
History testimonies the toughness of pyrethrum which has survived a long period and stiff competition
UNIDO
4


Pyrethrum plant
Chrysanthemum - 300 species of herbs and under-shrubs
C. cinerariaefolium
perennial plant, 60-70 cm tall, fibrous roots -
travelling to depth of 2m or more, flowers for few weeks but in
high altitude tropical zone continuous (effective life 5-8 yrs)
in Kenya flowers 7-10 months with nearly same harvest per year
White flowers with yellow centre.
Needs dry climate (60-80 cm/a), well drained slightly
alkaline soils and altitude of 1500-3000 m
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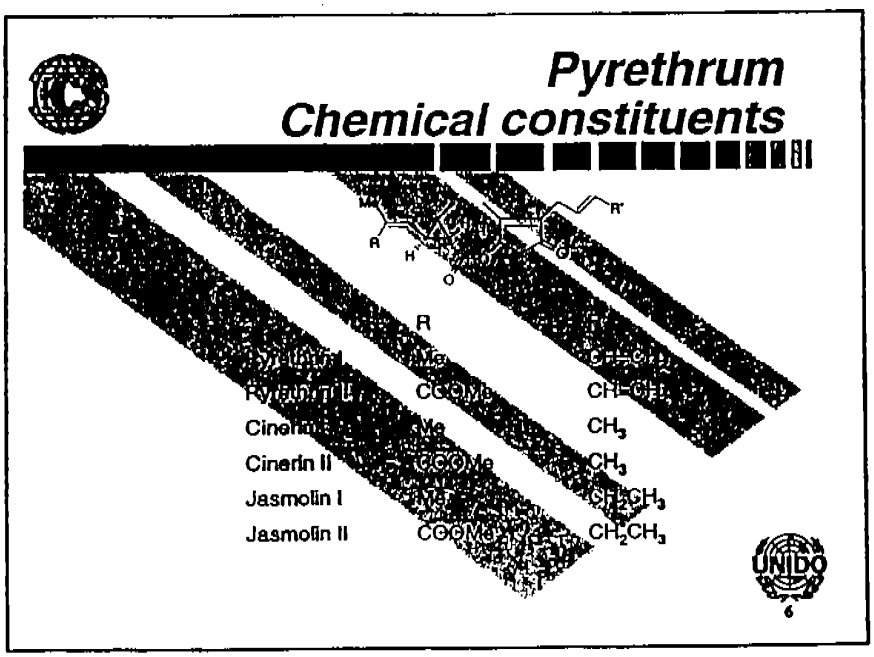
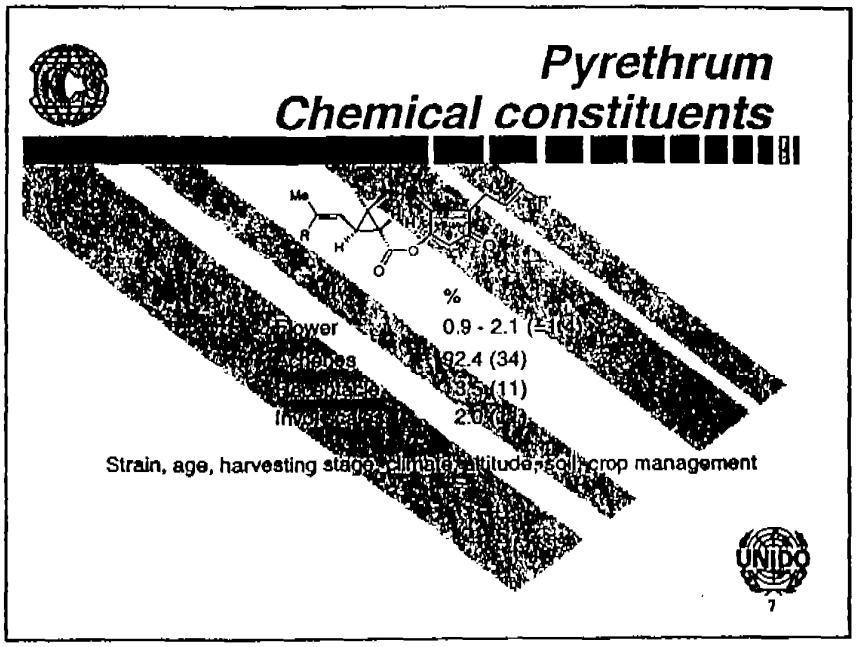
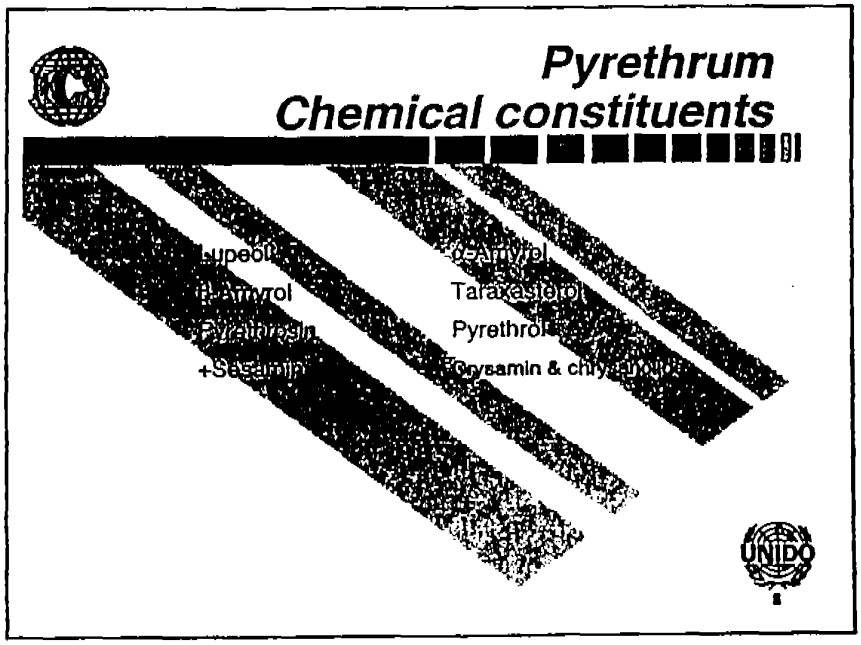
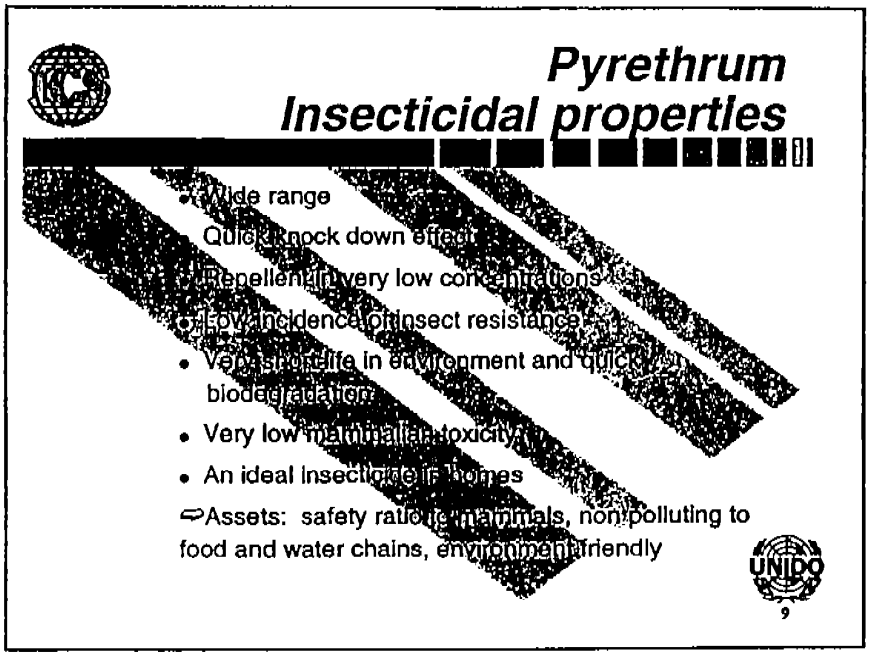
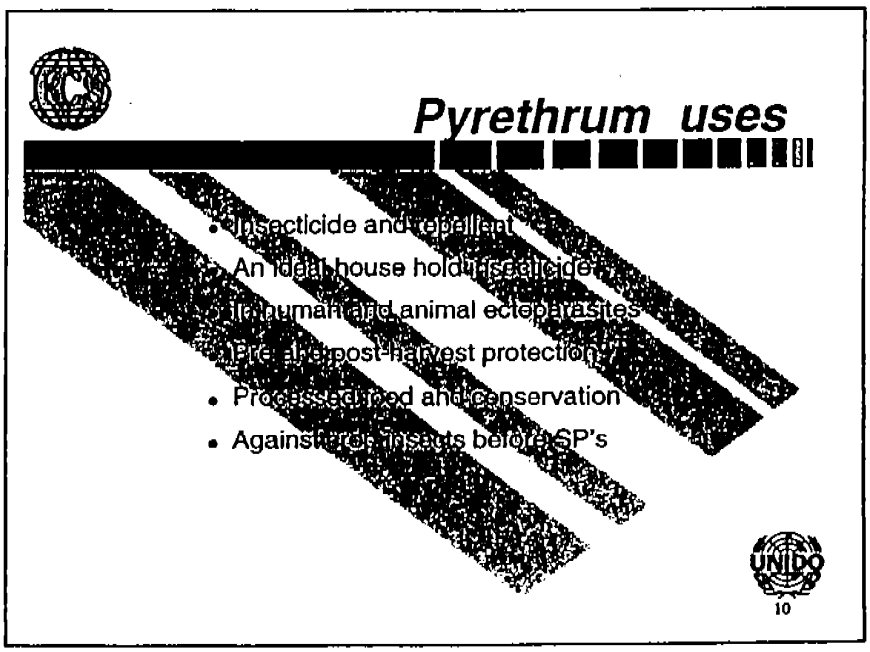
5

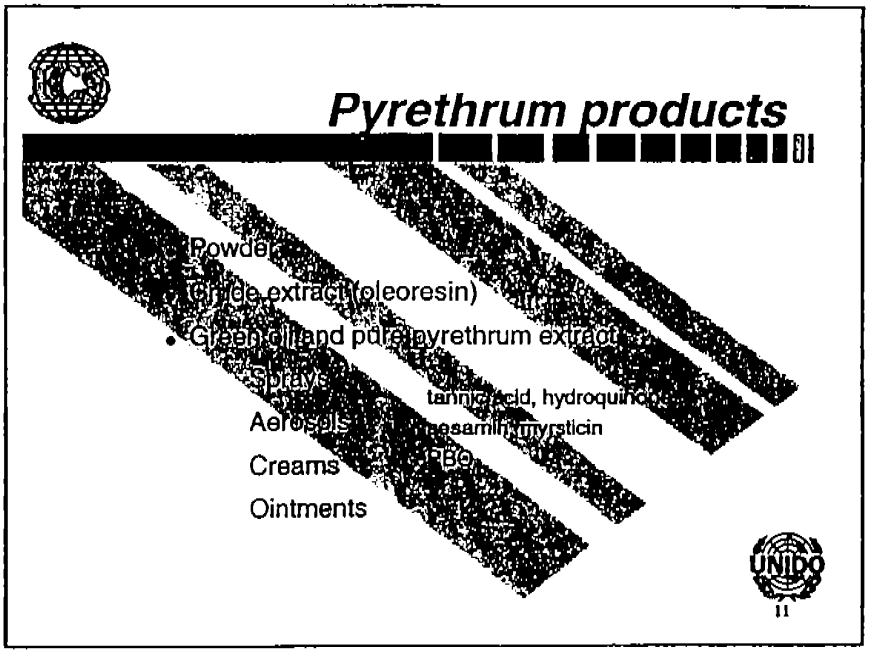

Pyrethrum
Chemical constituents
R
Cinerin I
Cinerin II
Jasmolin I
Jasmolin II
CH=CH2
CH3
CH3
CH2CH3
CH2CH3
UNIDO
6

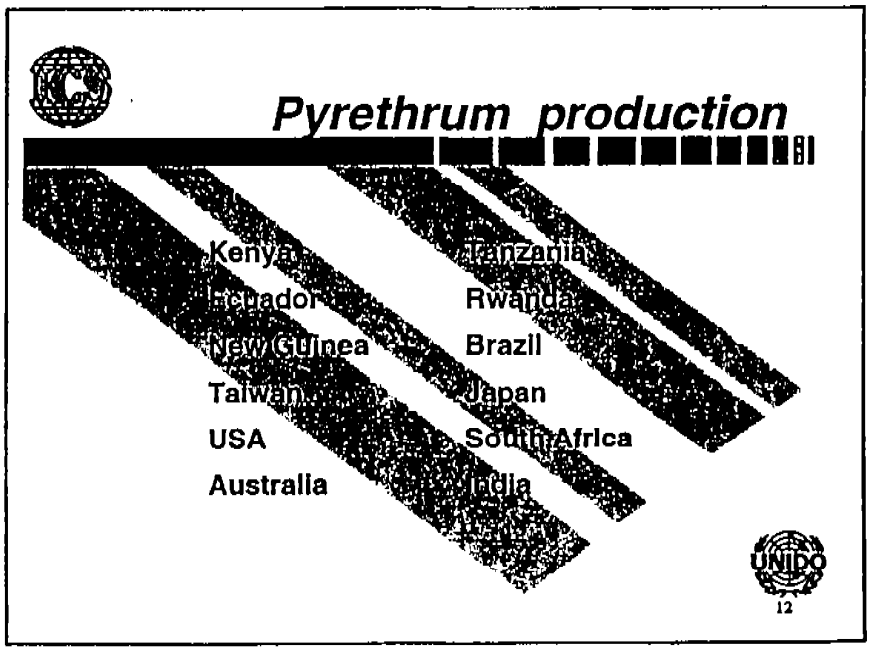

Pyrethrum
Chemical constituents
%
0.9 - 2.1 (=1
92.4 (34)
(11)
2.0
Strain, age, harvesting stage, climate, altitude, soil, crop management
7

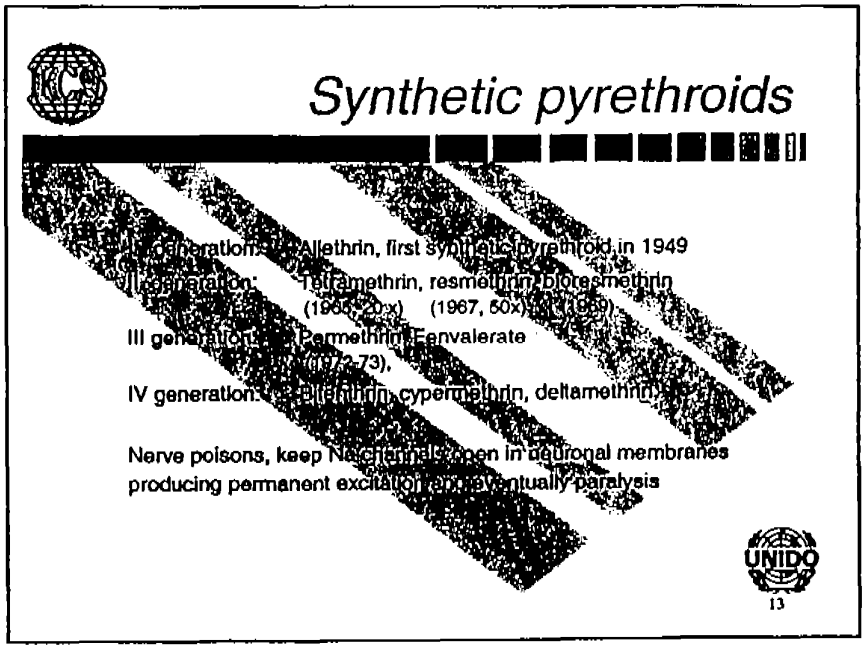

Pyrethrum
Chemical constituents
Lupeol
β-Amyrol
+Sesamin
α-Amyrol
Taraxasterol
Pyrethrol
Cinerin & chrysanthemic acid
8

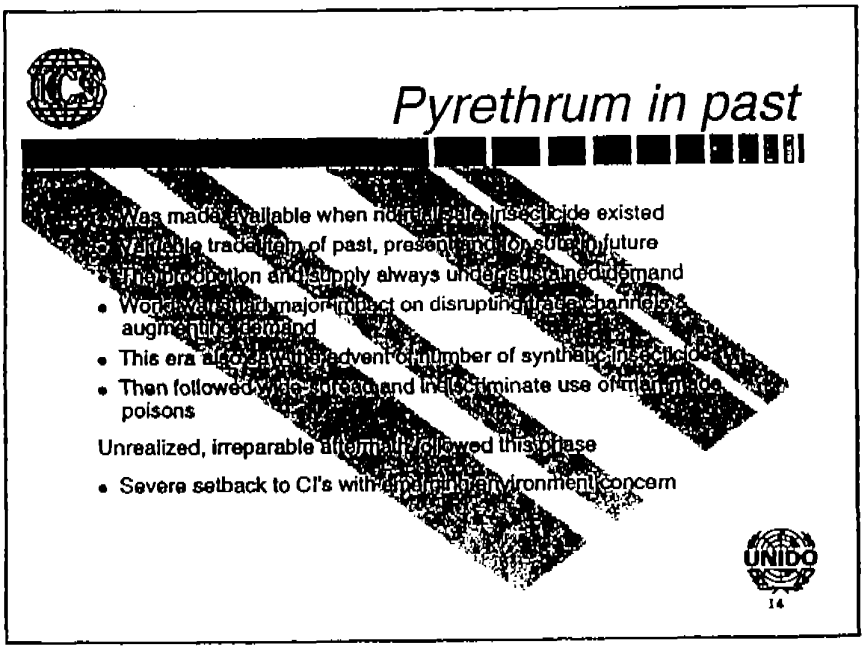

Pyrethrum
Insecticidal properties
• Wide range
Quick knock down effect
Repellent in very low concentrations
Low incidence of insect resistance
• Very short life in environment and quick biodegradation
• Very low mammalian toxicity
• An ideal insecticide in homes
Assets: safety ratio for mammals, non polluting to food and water chains, environment friendly
UNIDO
9

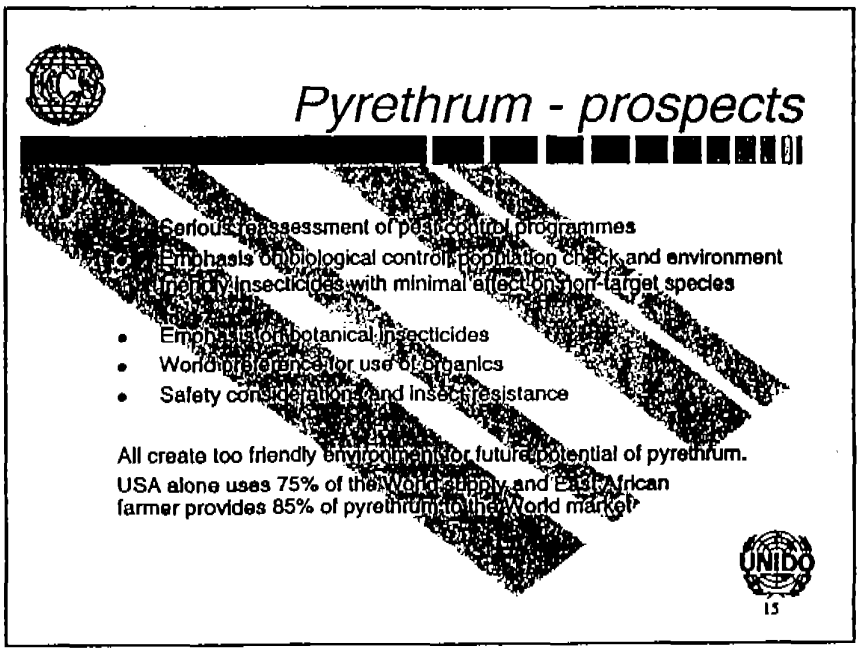

Pyrethrum uses
• Insecticide and repellent
An ideal house hold insecticide
In human and animal ectoparasites
Pre and post-harvest protection
• Processed food and conservation
• Against pests insects before SP's
UNIDO
10

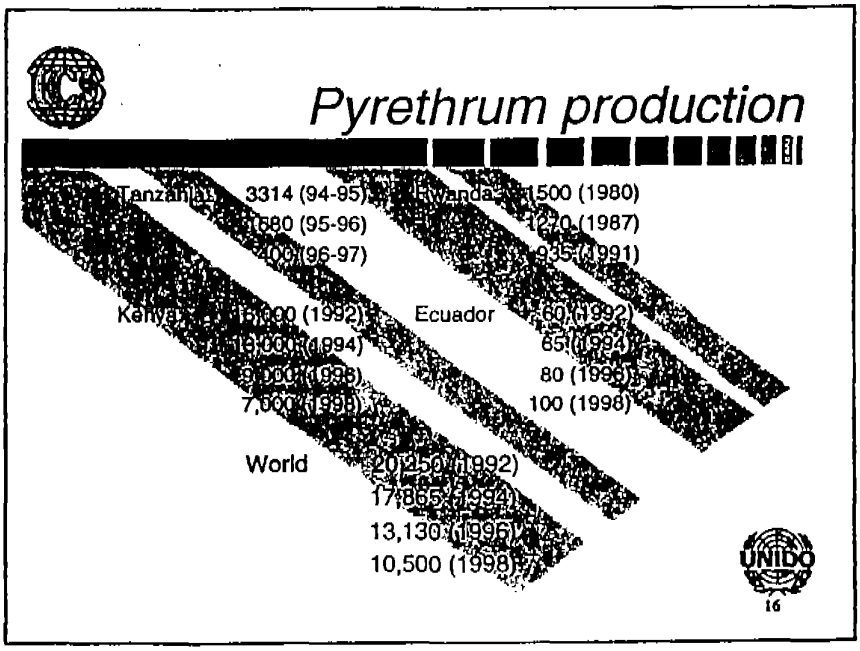

Pyrethrum products
Powder
Crude extract (oleoresin)
Green oil and pure pyrethrum extract
Sprays
Aerosols
Creams
Ointments
tannic acid, hydroquinone
sesamin, myristicin
PBO
UNIDO
11

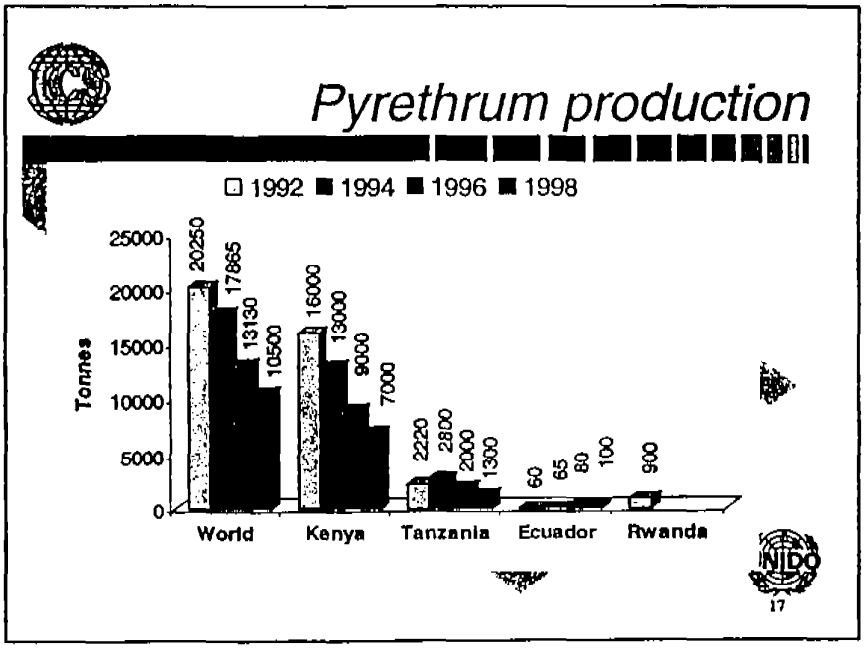

Pyrethrum production
Kenya
Ecuador
New Guinea
Taiwan
USA
Australia
Tanzania
Rwanda
Brazil
Japan
South Africa
India
UNIDO
12

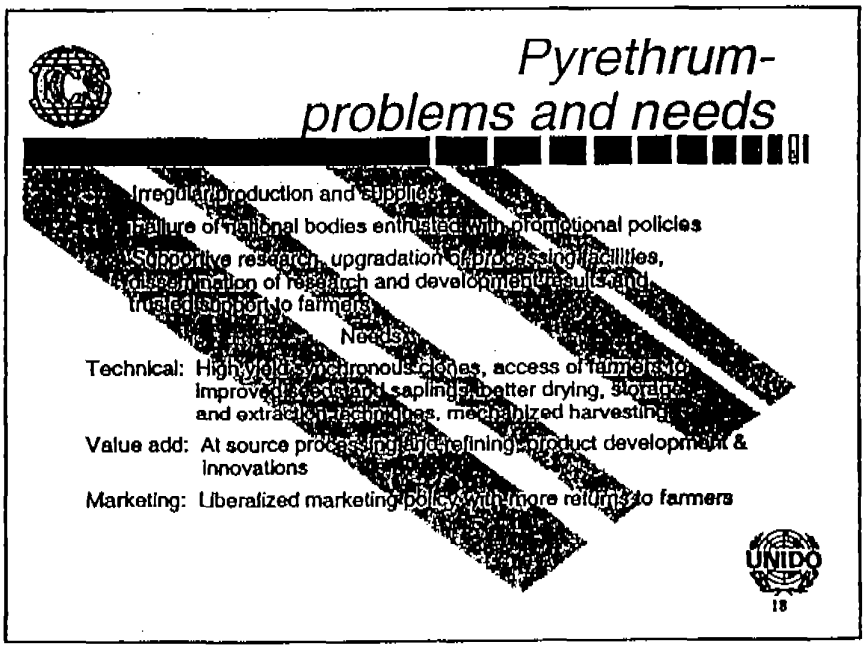

Synthetic pyrethroids
I generation: Allethrin, first synthetic pyrethroid in 1949
II generation: Tetramethrin, resmethrin, bioresmethrin
(1965, 20x) (1967, 50x) (1969)
III generation: Permethrin, Fenvalerate
(1972,73),
IV generation: cypermethrin, deltamethrin
Nerve poisons, keep Na channels open in neuronal membranes
producing permanent excitation and eventually paralysis
UNIDO
13


Pyrethrum in past
Was made available when no reliable insecticide existed
Valuable trade item of past, present and consolidation/future
The production and supply always under sustained demand
World War II had major impact on disrupting trade channels &
augmenting demand
This era also saw the advent of number of synthetic insecticides
Then followed wide spread and indiscriminate use of these
poisons
Unrealized, irreparable aftermath followed this phase
Severe setback to CI's with regard to environment concern
UNIDO
14


Pyrethrum - prospects
Serious reassessment of pest control programmes
Emphasis on biological control, population check and environment
friendly insecticides with minimal effect on non-target species
Emphasis on botanical insecticides
World preference for use of organics
Safety considerations and insect resistance
All create too friendly environment for future potential of pyrethrum.
USA alone uses 75% of the World supply and East African
farmer provides 85% of pyrethrum to the world market
UNIDO
15


Pyrethrum production
Tanzania
3314 (94-95)
580 (95-96)
400 (96-97)
Rwanda
1500 (1980)
1270 (1987)
935 (1991)
Kenya
16,000 (1992)
19,000 (1994)
7,000 (1998)
Ecuador
60 (1992)
65 (1994)
80 (1996)
100 (1998)
World
20,250 (1992)
17,865 (1994)
13,130 (1996)
10,500 (1998)
UNIDO
16


Pyrethrum production
1992 1994 1996 1998
Tonnes
25000
20000
15000
10000
5000
0
20250
17865
13130
10500
16000
13000
9000
7000
2220
2800
2000
1300
60
65
80
100
900
World
Kenya
Tanzania
Ecuador
Rwanda
17


Pyrethrum-
problems and needs
Irregular production and supplies
Failure of national bodies entrusted with promotional policies
Supportive research, upgradation of processing facilities,
dissemination of research and development results and
trusted support to farmers
Needs:
Technical: High yields, synchronous clones, access of farmers to
improved seeds and sapling, better drying, storage
and extraction techniques, mechanized harvesting
Value add: At source processing and refining, product development &
innovations
Marketing: Liberalized marketing policy with more returns to farmers
18

PARTICIPANT LIST FOR WORKSHOP ON INDUSTRIAL UTILIZATION OF PYRETHRUM, DAR ES SALAAM (SHERATON HOTEL), 29 – 30 MAY 2000

NO.	NAME	INSTITUTION	ADDRESS	TEL./EMAIL
1.	Wilfred J. Swai	TPPMCL	P.O. Box 63, Mafinga	255-061-772054
2.	G.S. Mkassi	Ministry of Industry and Trade	P.O. Box 9503, D'salaam	180075 - 77
3.	J. Baruti	NEMC	P.O. Box 63054, Dar es salaam	127056
4.	C.L.C. Migiro	**Cleaner Production Centre of Tanzania**	P.O.Box 23235	602338/602340 cpt@udsm.ac.tz
5.	F.F. Katagira	Ministry of Agriculture, & Cooperatives Plant Protection Department	P.O. Box 9071, Dar es Salaam	865641/3 ipm@africaonline.co.tz
6.	A.S. Nkwama	Farmer	P.O. Box 1, Makete	8
7.	B.E.G. Kiwovele	Pyrethrum Research Programme ARI- Uyole	P.O.Box 400, Mbeya, Tanzania	Fax :065-510065/Tel: 065 51036: mail uyole@ud.co.tz
8.	O.J. Luvanda	*Tanzania Pyrethrum Farmers Assoc.*	P.O. Box 8209, Dar es Salaam	137995
9.	P. Masonda	Mafinga	P.O. Box 74, Mafinga	772030
10.	John M. Liwenga	*Tanzania Pyrethrum Board*	P.O. Box 4817, Dar es Salaam	-
11.	G.M. Mbeyela	Tanzania Pyrethrum Board	P.O. Box 72, Mbeya	065-4334
12.	C. Ole Losai	*Tanzania Pyrethrum Board*	P.O. Box 2716, Arusha	0811 651820
13.	G.Burrell	PPG	P.O. Box 425, Arusha	0811 651762/ Email:geof burrell@hbaro.co.tz

14.	John Belt	**FAIDA – SEP**	**P.O. Box 13869, Arusha**	0811-511551 057-503549
15.	**A. Rwazo**	TPRI	P.O. Box 3024, Arusha	0811-653717, tpri@habari.co.tz.
16.	A. Choma	Treasury	P.O. Box 9111, Dar es Salaam	113228
17.	E.T. Njiku	Ministry of Agriculture, Dar es Salaam Farmers' Education Publicity Unit	P.O. Box 2308, Dar es Salaam	116496/700860
18.	Gennaro Longo	**ICS – UNIDO**	99, Padriciano, TRIESTE	0039-040-9228104
19.	Karan Vasisht	ICS – UNIDO	99, Padriciano, TRIESTE	0039-040-9228108
20.	Jamidu Katima	University of Dar es Salaam	P.O. Box 35131, Dar es Salaam	jkatima@cpe.udsm.ac.tz
21.	M.I. Oommen	TPPMCL	P.O. Box 63, Mafinga	061-77 2054 / 061- 772559
22.	Mansoor Daya	Mansoor Daya Chemicals	P.O.Box 2999 Dar es Salaam	860130
23.	Rasik K. Shah	Coil Products, Kenya	P.O Box 9709, Nakuru, Kenya	(37) 211720 / 213556
24.	Elisha Mahenge	Buyer	P.O. Box 1247, Mbeya	065-500677
25.	Paskal Leonard	Farmer	P.O. Box 48, Mbulu	
26.	Ephraem Mhekwa	Tanzania Pyrethrum Board	P.O.Box 4817, Dar es Salaam	0811325726
27.	Edward Materu	Tanzania Pyrethrum Board	P.O. Box 4817, Dar es Salaam	0811 616750
28.	S.D. Khan	Coil Markets (K) Ltd.	P.O. Box 9709, Nakuru, Kenya	(37) 211720 / 213556
29.	Vittorio de Rinaldini		Italy, P.O.Box 152, 20017. Rho-Mi	+39 029301015
30.	Sylvain Nzabagamba,	OPYRWA, Rwanda	**Rwanda BP 79 Ruhenge Tel: 08300727**	(250) 546306/7 Fax (250) 546 364
31.	Zainab Mshoro	TCCIA	P.O. Box. ..... Dar es Salaam	
32.	S.L. Mtega	Government Chemist, Chief Government Chemist Laboratory	**P.O. Box 164, Dar es Salaam**	113383/4 51-113320
33.	George Chale	Dawa ya Mbu	P.O. Box 2982, Dar es Salaan	866651
34.	Widmel Mushi	TPPMCL	P.O. Box 10221, Dar es salaam	137995
35.	Felix Ugbor	UNIDO	**UNDP, P.O.Box 9182; D' Salaam**	112527