Solar Cooker Fieldtest in South Africa

Eberhard Biermann et. al. (1999)

Technical Field:
- [x] Energy / Environment (E)
- [ ] Water / Sanitation (W)
- [ ] Agriculture (A)
- [ ] Foodprocessing (F)
- [ ] Manufacturing (M)

This Technical Information is available in:
- [x] English (e)
- [ ] French (f)
- [ ] German (g)
- [ ] Spanish (s)
- [ ] Other:.....

Firewood is the traditional energy for cooking in many countries of the developing world. Many people suffer from the increasing scarcity of firewood – especially in the dry zones of the African continent. Global figures indicate that in 1980, 500 million people had serious problems with their supply. This problem now concerns about 2 billion people!

Especially in rural areas, but also in urban fringe zones marked by a lack of infra-structure, families, community facilities (schools, hospitals, etc.) and refugee groups suffer under the increasing scarcity and expense of traditional cooking energy sources. Solar cookers designed to allow extensive retention of present cooking and nutritional habits would appear to be a practical alternative to the presently employed means of cooking, but this requires that the models offered be safe, simple to use and affordable for the ultimate users.

General information

There is something fascinating about solar cookers. Anyone who has ever watched a pot of water being boiled “just” by the sun is sure to have been very impressed.

Likewise, the principle behind solar cooking is as fascinating as it is simple: sun rays are converted to heat and conducted into the cooking pot.

All over the world, people involved in the design and application of solar cookers are investing efforts in the further development of relevant solar cooking options. Within the scope of two studies a total of 168 different solar cookers were catalogued. Of the 168 different solar cookers, the most frequent type, accounting for 95 models, was the box cooker, followed by 51 kinds of concentrator-type and 22 collector-type cookers. (GTZ, 1991 and 1998).

In Europe, the solar cooker designers have joined forces within the *European Committee for Solar Cooking Research* (ECSCR). All serious research activities of relevance - including GTZ's own efforts - are undertaken in cooperation with this organisation and benefit from its expertise. In the spring of 1994, with BMBF assistance, ECSCR conducted in Almeria, Spain, a solar cooker test for the purpose of investigating the technical performance capabilities of such equipment. Many designers and small-scale producers have in recent years made notable progress in the technical advancement of solar cookers.

Unfortunately, past solar cooker projects in developing countries have tended to achieve only modest results. Too little attention has been paid to the social context, as defined by the needs of potential users. Few needs-oriented cooking profiles have been drawn up for target regions offering conditions conducive to the use of solar cookers. But such profiles are vitally important as a basis for appropriate selection and modification of solar cookers.

gate Information Service / gtz, PO Box 5180, 65726 Eschborn, Germany
Phone: +49 (0)6196 / 79-3093, Fax: +49 (0)6196 / 79-7352, Email: gate-id@gtz.de, Internet: http://www.gtz.de/gate/

Unless the technical aspects are accommodated to the people's needs, the solar cooking technology will never be able to gain any real popularity.

Solar Cookers in Practice - A Comparative Field Test in South Africa
Since 1996, within the scope of a pilot program, GTZ and Department of Minerals and Energy (DME), South Africa have been conducting a comparative field test in the dry, northwestern part of South Africa. The purpose of the solar cooker field test is to clarify both the application potential of solar cookers in South Africa and, even more so, the extent to which potential target groups can be expected to accept the new cooking option. The pilot program is also intended to show whether solar cookers must be regarded as a "niche solution" or perhaps "have what it takes" for large-scale dissemination.

Program Phase I, Field Test
The dissemination of solar cookers must begin with an analysis of the local situation, i.e., of traditional cooking habits and local needs - not with the selection of a certain type of cooker. The main aspects of local cooking traditions and conditions can be compiled in „cooking profiles“. A cooking profile is presented in the annex.

On the basis of the pertinent cooking profiles, seven different solar cooker models were selected for testing: four box cookers, one concentrator and two collector-type cookers. All seven types of cooker prooved able to handle the traditional dishes. These models are presented in the appendix.

With a view to obtaining seasonally relevant results (solar season), the solar cookers were tested by 66 families and 14 institutions, for an entire year. Thirty families cooking without solar cookers served as the control group. Each family used one type of cooker over two months‘ time before switching to the next model. Users and non-users alike filled out on-the-spot questionnaires and were interviewed by the team’s sociologists. A data base with more than 400.000 single informations was established.

Regarding Acceptance
Solar cookers were shown to be the most frequently used cooking implements along with wood (open fires, woodstoves and coal-burning stoves). These were followed by cookers that operate on gas, kerosene or electricity. The results indicate good acceptance of solar cookers among the test families: Solar cookers were used at least as frequently as other household cooking options.

Analysis of the results showed that:

- the cookers were used intensively by the families (40% frequency of use),
- the families were satisfied with 93% of all solar cooking processes,
- all families were able to achieve considerable savings on household energy (on average 38%), and spent significantly less time on collecting firewood,
- nearly 100% of all the families that used the cookers have bought one at a reduced price after the fieldtest (second hand cooker).

It was demonstrated that, under suitable conditions, solar cookers are accepted by users. Also demonstrated was that it pays to use solar cookers. Furthermore it was shown that potential users are generally interested in purchasing such cookers.

Consequently, the second phase of the South African pilot program aims to determine how and to what extent solar cookers can be rendered commercially successful.

Program Phase II, Pilot Dissemination
Four different solar cooker models - one South African and three European - are to be placed on the market. The models in question are those which achieved the best results during the first-phase field test. European designers and South

gate Information Service / gtz, PO Box 5180, 65726 Eschborn, Germany
Phone: +49 (0)6196 / 79-3093, Fax: +49 (0)6196 / 79-7352, Email: gate-id@gtz.de, Internet: http://www.gtz.de/gate/

African producers worked together to improve the solar cookers and prepared them for local production.

Several hundred solar cookers have been shipped out by their producers, and, if all goes according to the plan, 2,000 solar cookers will have been commercially disseminated by the end of the project.

At the beginning of phase II it was already becoming apparent that people attach more importance to the cookers' purchase price than had been previously assumed. Thus, it will be of decisive importance for the future of solar cookers that they be mass produced in order to achieve lower prices without sacrificing quality.

Intensive monitoring of all significant processes will enable identification of determining factors for the cookers' successfull commercial dissemination and the project's potential for transfer to other countries.

Recommendations
Generally applicable recommendations for future solar cooker activities in other emerging countries will be compiled in a compendium. The transferability of the compendium's basic data will be discussed with representatives of other interested african countries at a regional solar cooker conference in the vicinity of Johannesburg (27 to 29 November 2000).

If solar cooking is to fulfill its potential, a number of conditions will have to be met:

- Solar cookers must be high quality products, user friendly, high performance, durable and cost-efficient.
- Dissemination, financing and user support must comply with the standards set by other economic or development activities.
- The political framework must be conducive to sustainable success, favouring the most promising technologies without crippling healthy competition.

Conclusion
Having concluded the first phase of the solar cooker field test, the basic acceptance problems and the issue of appropriate conditions for use may be regarded as understood. In the right context, selected solar cookers find acceptance also by low-income communities as an option for cooking and baking.

The decisive factors governing dissemination and use will be primarily of an economic nature, e.g., the purchase price and the local availibility of services and small loans. Such conditions can be influenced - and it is well worth the trouble to turn solar cooking from a concept into a reality.

References and further Information:

- Moving Ahead with Solar Cookers - Acceptance and Introduction to the Market (GTZ 1999)
  www.gtz.de (in Erarbeitug bei 02)

- DME/GTZ (1997), Solar Cooker Field Test in South Africa, Phase 1, Volume 1, Main Report, Johannesburg, December 1997
- ECSCR (1994): Second International Solar Cooker Test, Summary of Results, Second Edition, Lodève, June 1994, published in BMZ aktuell 060, Bonn

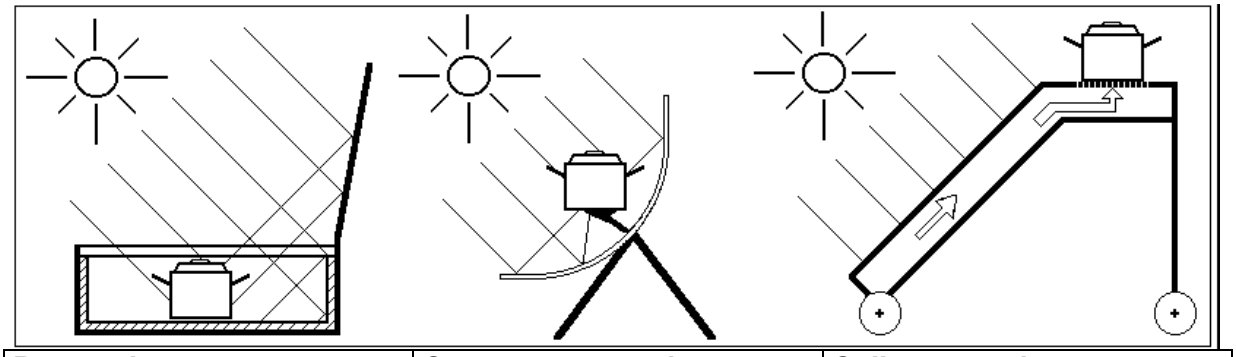
Useful Link:

➢ http://www.solarcookers.co.za

gate Information Service / gtz, PO Box 5180, 65726 Eschborn, Germany
Phone: +49 (0)6196 / 79-3093, Fax: +49 (0)6196 / 79-7352, Email: gate-id@gtz.de, Internet: http://www.gtz.de/gate/

Appendix - Technical Data of South African Test Cookers

Basically each of the many cookers fits into one of the following three categories:



Box cookers	Concentrator cookers	Collector cookers
are insulated boxes with a glass top, often with a directionally adjustable reflective lid, designed to surround a cooking pot. Box cookers exploit both direct and diffuse solar radiation. They require little intervention by the user and are characterized by widely divergent thermal performance	concentrate direct insolation on a cooking pot. They are quite efficient but require the user's attention for keeping them aligned with the sun and maintaining good performance	are made up of two parts that often share a single casing: a collector for gathering heat and a cooking range for exploiting the yield. These powerful devices make use of diffuse and direct solar radiation. They are, however, rather complicated to build.

ULOG

Type of cooker: Conventional box cooker with wooden frame

Selected Results of the 1994 ECSCR Comparative Solar Cooker Test and 1998/99 Tests in South Africa	
Dimensions (cooking pos.):	66 x 67 x 104 [cm]
Number of pots and nom. volume:	1 removable pot (5 l)
Test pot content:	2.5 l
Aperture surface:	0.24 m² (without reflector)
Heating time (water):	
- cold start (40 - 80°C)	*94 minutes
- cold start (40 - 96°C)	*takes 120 minutes to reach 91°C
- hot start (40 – 80°C)	*66 minutes/**77 minutes/***91 minutes
- hot start (40 – 96°C)	*107 minutes
Max. temperature (oil):	*124°C after 130 minutes
Continuous cooking:	*boils 7.5 l of water in a day
Heat loss with lid open:	*cools from 95°C to 80°C in 5 min
Comments:	average thermal performance for a box cooker; very large nominal pot volume for this aperture; rarely requires tracking
Handling:	two-step access to pot; easy tracking; easy to use, easy to transport, comes with instructions
Application:	family-size cooker
Evaluation for technology transfer/local production:	easy short-series reproduction; recommended performance-enhancing measures for SA model: low-iron glass and conductive absorber
Contact address:	Gruppe ULOG, Morgartenring 18, CH-4054 Basel, Switzerland Tel: +(41) 61-3016622 ; Fax: +(41) 61-3014959
Legend:	*ECSCR (E) **European model (RSA) ***prototype built in RSA (RSA)

gate Information Service / gtz, PO Box 5180, 65726 Eschborn, Germany
Phone: +49 (0)6196 / 79-3093, Fax: +49 (0)6196 / 79-7352, Email: gate-id@gtz.de, Internet: http://www.gtz.de/gate/

SunStove

Type of cooker: Box cooker with plastic enclosure and no external reflector

Selected Results of the 1994 ECSCR Comparative Solar Cooker Test and 1998/99 Tests in South Africa	
Dimensions (cooking pos.):	66 x 63 x 38 [cm]
Number of pots and nom. volume:	one, two or three removable pots
Test pot content:	1.5 l
Aperture surface:	0.28 m²
Heating time (water):	
- cold start (40 - 80°C)	*90 minutes
- cold start (40 - 96°C)	*takes 120 minutes to reach 87°C
- hot start (40 – 80°C)	*68 minutes/**62 minutes/
- hot start (40 – 96°C)	takes 120 minutes to reach 93°C/**90 minutes/***76 minutes
Max. temperature (oil):	*114°C after 130 minutes
Continuous cooking:	*boils 3 l of water in a day
Heat loss with lid open:	*cools from 90°C to 80°C in 5 min
Comments:	*low thermal performance for a box cooker; average pot content for the aperture; rarely requires tracking
Handling:	easy, two-step access to pot; very simple to track and use, easy to transport; light wind can open transparent cover, which could be more securely mounted.
Application:	cooker for small families; suitable for low-temperature cooking
Evaluation for technology transfer/local production:	Is already produced in South Africa
Contact address:	SunStove, 1 Parklands Saldahana Street, 1501 Benoni, RSA Tel/Fax: +(27)119692818 R. Wareham, 3140 North Lily Rd, Brookfield, Wi 53005, USA Tel +(1)4147811689; Fax +(1)414810455
Legend:	*ECSCR (E) **original model (RSA) ***original model with absorber (RSA)

REM5

Type of cooker: Conductive box cooker

Selected Results of the 1994 ECSCR Comparative Solar Cooker Test and 1998/99 Tests in South Africa	
Dimensions (cooking pos.):	88 x 101.5 x 96 [cm]
Number of pots and nom. volume:	2 removable pots (5 l / 1.5 l)
Test pot content:	2.5 l
Aperture surface:	0.36 m² (without reflectors)
Heating time (water):	
- cold start (40 - 80°C)	*48 minutes
- cold start (40 - 96°C)	* 66 minutes
- hot start (40 – 80°C)	*22 minutes/**35 minutes/***45 minutes
- hot start (40 – 96°C)	*42 minutes/**48 minutes/***62 minutes
Max. temperature (oil):	*147°C after 130 minutes
Continuous cooking:	*boils 12.5 l of water in a day
Heat loss with lid open:	*cools from boiling temperature to 80°C in 5 min
Comments:	excellent thermal performance for a box cooker; average nominal pot content; rarely requires tracking
Handling:	one-step access to pot; easy to track, use and transport; comes with instructions for use
Application:	family-size cooker
Evaluation for technology transfer/local production:	original model: high-quality materials and complicated assembly; SA model (simplified) requires iron-free glass for better performance
Contact address:	Synopsis, Route d'Olmet, F-34700 Lodève, France Tel: +(33)467440410; Fax: +(33)467440601; Email: synopsis@wanadoo.fr
Legend:	*ECSCR (E)**European model (RSA) ***prototype built in RSA(RSA)

gate Information Service / gtz, PO Box 5180, 65726 Eschborn, Germany
Phone: +49 (0)6196 / 79-3093, Fax: +49 (0)6196 / 79-7352, Email: gate-id@gtz.de, Internet: http://www.gtz.de/gate/

Schwarzer 1
Type of cooker: Flat plate collector cooker

Selected Results of the 1994 ECSCR Comparative Solar Cooker Test	
Dimensions (cooking pos.):	273 x 135 x 110 [cm]
Number of pots and nom. volume:	2 non-removable pots (2 x 5 l)
Test pot content:	2 x 2.5 l
Aperture surface:	1 m² (without reflectors)
Heating time (water):	
- cold start (40 - 80°C)	46 minutes
- cold start (40 - 96°C)	54 minutes
- hot start (40 – 80°C)	26 minutes
- hot start (40 – 96°C)	39 minutes
Max. temperature (oil):	*157°C after 130 minutes
Continuous cooking:	boils 30 l of water in a day
Heat loss with lid open:	cools from boiling temperature to 80°C in 7 minutes
Comments:	excellent thermal performance; small pot volume for the aperture; rarely requires tracking
Handling:	easy, one-step access to pots; acceptable tracking; practical power control; cleaning can be difficult due to the fixed pots; cooker not easy to transport, but operation easy to learn
Application:	cooker for families and in modular applications, for institutions; suitable for cooking and roasting
Contact address:	Prof. K. Schwarzer, FH Aachen, Ginsterweg 1, D-52428 Jülich, Germany Tel.: +(49)2461993177; Fax: +(49)2461993199

SK12
Type of cooker: "Deep Focus" concentrator

Selected Results of the 1994 ECSCR Comparative Solar Cooker Test and 1998/99 Tests in South Africa	
Dimensions (cooking pos.):	143 x 163 x 125 [cm]
Number of pots and nom. volume:	1 removable pot (12 l)
Test pot content:	6 l
Aperture surface:	1.54 m² (reflector)
Heating time (water):	
- cold start (40 - 80°C)	*27 minutes/**27 minutes/***30 minutes
- cold start (40 - 96°C)	*44 minutes/**38 minutes/***39 minutes
- hot start (40 – 80°C)	-
- hot start (40 – 96°C)	-
Max. temperature (oil):	*198°C after 130 minutes
Continuous cooking:	*boils 48 l of water in a day
Heat loss with lid open:	*cools from boiling temperature to 83°C in 15 min
Comments:	excellent thermal performance for a concentrator-type cooker; small nominal pot content for this size of aperture; requires regular tracking
Handling:	easy, one-step access to pot; easy tracking, but level ground required; acceptable operation, but difficult to relocate
Application:	cooker for large families and, in modular application, for small institutions; suitable for cooking and roasting
Evaluation for technology transfer/local production:	easily reproducible; reflector material must be protected against corrosion; a folding type of steady stand is under development; transport and assembly require optimization
Contact address:	Dr. D. Seifert, Siedlungsstrasse 12, D-84524 Neuötting, Germany Tel./Fax: +(49)867170413, Email: bdiv.seifert@t-online.de
Legend:	*ECSCR (E)**European model (RSA) *** prototype built in RSA (RSA)

gate Information Service / gtz, PO Box 5180, 65726 Eschborn, Germany
Phone: +49 (0)6196 / 79-3093, Fax: +49 (0)6196 / 79-7352, Email: gate-id@gtz.de, Internet: http://www.gtz.de/gate/

REM15

Type of cooker: Conductive box cooker

Selected Results of the 1994 ECSCR Comparative Solar Cooker Test	
Dimensions (cooking pos.):	114 x 117 x 179 [cm]
Number of pots and nom. volume:	2 removable pots: one 15-l pot and two 2.5-l pots
Test-pot content:	7.5 l
Aperture surface:	0.60 m² (without reflectors)
Heating time (water):	
- cold start (40 - 80°C)	40 minutes (moderately preheated)
- cold start (40 - 96°C)	66 minutes
- hot start (40 – 80°C)	32 minutes
- hot start (40 – 96°C)	55 minutes
Max. temperature (oil):	157°C after 130 minutes
Continuous cooking:	boils 37.5 l of water in a day
Heat loss with lid open:	cools from boiling temperature to 80°C in 8 min
Comments:	excellent thermal performance for a box cooker; very large nominal pot content for the aperture; rarely requires tracking
Handling:	one-step access to pot; tracking mechanism could be improved, e.g., better wheels; easy to use and, in transport position, to transport; operation easy to learn
Application:	cooker for large families and, in modular application, for small institutions
Contact address:	Synopsis, Route d'Olmet, F-347 Lodève, France Tel: +(33)467440410; Fax: +(33)467440601; Email: synopsis@wanadoo.fr

Schwarzer 2

Type of cooker: Flat plate collector cooker

Selected Results of the 1994 ECSCR Comparative Solar Cooker Test	
Dimensions (cooking pos.):	302 x 192 x 175 [cm]
Number of pots and nom. volume:	2 non-removable pots (10 l / 5 l)
Test pot content:	5 l / 2.5 l
Aperture surface:	2 m² (without reflectors)
Heating time (water):	
- cold start (40 - 80°C)	50 minutes
- cold start (40 - 96°C)	64 minutes
- hot start (40 – 80°C)	6 minutes (large pot) / 14 minutes (small pot)
- hot start (40 – 96°C)	11 minutes (large pot) / 88 minutes (small pot
Max. temperature (oil):	182°C after 130 minutes
Continuous cooking:	boils 65 l of water in a day
Heat loss with lid open:	cools from boiling temperature to 80°C in 14 minutes
Comments:	excellent thermal performance; small nominal pot content for this size of aperture; rarely requires tracking
Handling:	easy, one-step access to pots; acceptable tracking; practical power control; cleaning can be difficult due to the fixed pots; cooker not easy to transport, but operation easy to learn
Application:	cooker for families and in modular applications, for small institutions; suitable for cooking and roasting
Contact address:	Prof. K. Schwarzer, FH Aachen, Ginsterweg 1, D-52428 Jülich, Germany Tel.: +(49)2461993177; Fax: +(49)2461993199

gate Information Service / gtz, PO Box 5180, 65726 Eschborn, Germany
Phone: +49 (0)6196 / 79-3093, Fax: +49 (0)6196 / 79-7352, Email: gate-id@gtz.de, Internet: http://www.gtz.de/gate/