Permanent Interstate Committee
for Drought Control in the Sahel

RENEWABLE ENERGIES:

TYPHA AUSTRALIS
THREAT OR ASSET?

Bundesministerium für
wirtschaftliche Zusammenarbeit
und Entwicklung

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Permanent Interstate Committee for Drought Control in the Sahel

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Foreword

The entire issue of energy, the environment and poverty is extremely complex, and cannot be reduced to the energies we know and use today. Agricultural and industrial residues and certain plants, in particular water plants, count among the potential non-conventional sources of energy. Using these plants as fuel can also help preserve local ecosystems.

Typha australis comes under this category of plant. It is an invasive plant of the reed family, which, thanks to its rapid growth, is colonising the flood plains of the Rivers Senegal and Niger. *Typha australis* is thus reducing the available cropland in the affected areas, impeding river traffic, and providing a habitat for the proliferation of granivorous birds.

It was decided to look at possible ways of using this plant, in order to protect man and the environment from its impact. Certain projects and programmes, including CILSS's PREDAS project and the Senegalo-German Domestic Fuel Project (PSACD/GTZ) have been involved in this procedure, which has indicated that the plant, originally seen uniquely as a threat, can in fact be used in various ways to benefit the population of the Sahel.

This brochure has been produced with the financial support of the German Federal Ministry for Economic Cooperation and Development (**BMZ**), and has benefited from the advice of PSACD. It aims firstly to present *Typha australis* and the threat it poses to the population of affected areas and to the environment, and secondly to look at the range of possible uses of the plant, some energy-related some not, which can turn this threat into a valuable asset and an instrument to reduce poverty, especially in rural areas.

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Executive Secretary of CILSS

Summary

Mali, Mauritania and Senegal are currently facing the proliferation of an invasive plant, ***Typha australis***, which is colonising, in particular, irrigated land (that comes under the authority of the Office du Niger in Mali and the OMVS and the SAED in Mauritania and Senegal). *Typha* australis poses the people living along the rivers with several problems. Most seriously, it reduces their access and that of their livestock to the water, resulting in lower harvests.

Since 1997, the association Pro-Natura has been experimenting with the carbonisation of *Typha* biomass, with a view to producing charcoal briquettes. *Typha* is available in such quantities in the Senegal and Niger valleys that it could replace a significant proportion of the charcoal produced from wood in these countries, thus reducing deforestation.

Tests have shown that the *Typha* briquettes are socially acceptable to households. Complementary studies are, however, still needed to investigate the economic and financial feasibility of this new branch, which could generate a large number of jobs for the disadvantaged populations living close to the two rivers.

Apart from carbonisation, there are other possible ways of using *Typha*, including biogas, basket-making, construction and animal fodder, making this plant a potential asset for the region.

In this brochure you will find an introduction to the biology of *Typha australis*, the threat it poses and the various ways of using to plant to limit propagation and minimise its negative impacts on the development of settled areas.

Biology of the Plant

Systematic Classification and Distribution

Typha australis is a tropical, subtropical and Mediterranean species of the Typhaceae family. It is a perennial, rhizomatous plant, and can reach a height of 3.50 m. The leaves are between 1 and 2 cm in breadth, and can grow to a length of 3 m. In the consistently humid environment, and in the brackish water whose salinity is never grater than 2 %, the plant grows densely.

Morphology

Typha australis is a herbaceous plant with fibrous roots. These have lateral rhizomes, each of which can produce one or more shoots. For limited periods the plant can survive in an environment without oxygen.

The inflorescence is candle-shaped and measures about 15 to 20 cm in length. It is brown in colour when mature. Within this candle, a large number of flowers are tightly packed.

Propagation by rhizomes

Multiplication

The plant multiplies by both seeds and rhizomes. At maturity, thousands of seeds (see photo) are transported by the wind and by irrigation water, and find a humid environment propitious for their development.

Local proliferation is ensured by the plant's rhizomes (see above) which have a huge capacity to multiply in a humid environment. In areas with year-round water and in the irrigation channels, the plant is propagated by both seeds and rhizomes.

The seeds of the *Typha australis* germinate in an almost total absence of oxygen. This peculiarity further accelerates the rate at which it can colonise an area to the detriment of other species, thus increasing the threat it poses to biodiversity. The same does not apply to multiplication by rhizomes, which can only develop in the presence of oxygen.

The Threat posed by *Typha*

Typha has existed for a very long time in the valley of the Senegal. It was traditionally used by women as a raw material for basket-making and building (fencing). The spread of the plant was limited because of the huge fluctuations in the level of the river and the salt water re-mounting the river from the sea.

The construction of the Diama and Manantali dams on the Senegal allow us to regulate the river water, but at the same time has produced conditions favourable to the proliferation of *Typha*, which has since become a veritable constraint on rural development in the region of the river. A similar situation prevails in the area served by the Office du Niger in Mali.

The consequences of this uncontrolled proliferation are numerous.

☞ *In agricultural and food terms*, the spectacular propagation of the plant within the irrigation systems, put at about 10 % per annum, cuts the efficiency of the irrigation systems, massively reduces rice harvests (from around 5 t to 1 t per hectare) and has induced farmers to abandon affected land. It also reduces the available cropland on the riverbanks, blocks access to the water for both the local people and their livestock, and provides a habitat suitable for the proliferation of granivorous birds, which are responsible for large-scale crop losses. It impedes river traffic, and rotting *Typha* shoots affect the water quality, thus hampering the development of fish resources.

☞ *In health terms*, the eutrophication of the large quantities of biomass produced every year makes the water unsuitable for certain purposes, such as drinking water, which means that the local people (especially women and children) have to walk much further to fetch drinking water from safe sources. Moreover, *Typha australis* provides a biotope favourable to the development of vectors of certain diseases, such as bilharzia and malaria.

☞ *In environmental terms*, *Typha australis* grows so rapidly that it strangles the other plant species traditionally used by the population living close to the river or by their livestock. It thus entails a serious risk that biodiversity will be eroded.

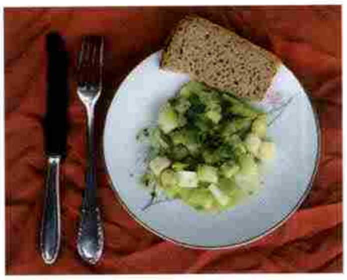
The proliferation of *Typha* is a constraint to rural development along the entire Senegal valley and in the main delta of the Niger; this justifies actions to use and control the development of the plant.

Eradicating *Typha*

Several techniques are conceivable in the fight against *Typha*, but we must bear the following in mind:

- ⇨ It is extremely difficult and time-consuming to destroy this plant manually (by pulling it out) because of the sheer size of the areas affected. This method could nevertheless be considered given that the starch content of the rhizomes (about 30%) could be used as a binding agent in the manufacture of *Typha* briquettes.
- ⇨ Mechanical control efforts would be expensive and probably injurious to the environment (use of heavy machinery in a fragile environment).
- ⇨ Chemical control would be the most effective, but also the most costly, and would definitely pose a threat to the environment.
- ⇨ Biological control methods are not yet available. No studies have yet been conducted on potential parasites of the plant.
- ⇨ Controlled burning can basically be discounted since the environment is always humid (and it would be almost impossible to reach the rhizomes).

It appears that one of the most promising options is to control the proliferation of the plant by using it. *Typha* is already used in several ways: by craftsmen and women, in traditional medicine, as a construction material, etc. *Typha* is also traditionally used in China, Australia and America as flour made from dried rhizomes. Young shoots are eaten fresh or boiled, and young leaves are used as a condiment.



Leaves can be used as a roofing material or to reinforce the coating of clay walls. They are used to make mattresses, mats, fencing or baskets.

Mats to protect a courtyard

Crafts products

Nets made of twisted fibres

In the valley of the Senegal, *Typha* is still used very little, but there is scope to expand the use of the plant, given the experiences gained in other countries and the enormous quantities of *Typha* biomass available.

Estimating Biomass and Potential for Charcoal Production

The quantity of biomass produced depends on the depth of the water. Satellite images of *Typha* stands in the delta of the Senegal allow us to identify three different categories of density (7.5 – 10, 10 – 15, 15 + kg/m²). Field analyses of the *Typha* populations allow us to estimate the production of useful biomass in the area under consideration (a pilot area of 411 ha) at a minimum of 20 t of dry material per hectare per annum.

The relation between fresh biomass and useful dry biomass gives a conversion factor of 0.173. If we take this, and apply it to the entire Senegal delta, with an area of 6,176 ha, we come up with an average quantity of useful dry biomass of 18 t/ha. If we extrapolate these figures for a 40 km stretch of the Senegal, we come up with an estimated total quantity of useful dry biomass of at least 200,000 t.

The yield[1] of carbonisation is 33 %, i.e. for every kilogram of dry *Typha* material we can expect to produce 0.33 kg charcoal. Thus, given the quantities of dry material estimated above for a 40 km stretch of the Senegal, some 65,000 t charcoal could be produced per annum.

If we then further extrapolate for the entire Senegal valley, we can estimate total dry biomass of 3 million tonnes, which could theoretically be used to produce some 170,000 tonnes charcoal, or more than 50 % of the total wood-based charcoal used in Senegal in 1997 (source: Observatoire des combustibles domestiques n° 7, June 1999).

[1] Yield achieved within the framework of tests conducted.

Exploitation and Use

There are several possible methods of harvesting *Typha*.

Manual harvesting

A trial conducted in the Senegal delta allowed us to ascertain the speed of manual harvesting using a sickle. An area of 30 m² was harvested per man-hour, which represented about 40 kg dry biomass.

Since *Typha* grows on muddy soils up to a depth of 1.40 m it is extremely difficult to organise manual harvesting as soon as the quantities are very large. Mechanical harvesting might be an option, but would generate fewer jobs.

Mechanical harvesting

An amphibian vehicle is manufactured in Denmark, which would be suitable for mechanically harvesting *Typha*. The vehicle has a working platform carried by 4 or 6 low-pressure balloon-tyred wheels. Various harvesting units can be mounted on the platform, including a cutter, a chopper, a conveyor and a binder.

Amphibious vehicle with balloon tyres and floating

The wheels can carry 1.3 tonnes each, which allows the vehicle to float with a load of around 4 tonnes. An amphibian vehicle of the JSP type could harvest between 32 and 40 tonnes of dry biomass a day.

Typha could also be harvested mechanically using cutter boats which provide a working platform fitted out with one- or two-screw engines with variable power providing for a speed of up to 8 km/h. The boat should be able to harvest about 10 tonnes an hour.

Cutter boat with front loader and a two-screw engine

Drying and Transport

The percentage of dry biomass produced from the fresh material varies depending on the depth of the water, between 45 % (at a depth of 1.20 m) and 62 % ($\pm$ 0 m). An average of 54 % has been calculated.

To keep transport costs down, the *Typha* should be dried where is it harvested. Under the climatic conditions typical for the Senegal delta the material can be dried in the sun for between 7 and 10 days, giving 80 % dry material. If the *Typha* is stacked as sheaves, the drying time will be longer.

For regular charcoal production it is important to have sufficient quantities of dry materials, which makes it essential to have enough drying space.

If the quantities are large, it could be more economical and less complicated to dry the *Typha* at the collection site.

The biomass is generally transported from the collecting point to the carbonisation site by small farmers with carts, thus generating significant income for the latter. By way of example, a small production unit with a capacity of 3 tonnes per day will need 20 cart trips (assuming that the cart can carry 150 kg per trip), which makes it possible to employ 4 to 5 cart-drivers per day.

Carbonisation and Briquette Production

If it is to replace at least some of the wood charcoal currently used, *Typha* fuel must be socially acceptable, have similar burning properties and be competitively priced.

Carbonisation is a partial combustion process using pyrolysis. There are two ways of producing briquettes from biomass:

- extreme compression of the biomass to produce briquettes which are subsequently carbonised;
- carbonisation of the biomass followed by production of the briquettes from the coal dust using a binding agent.

PREDAS has run technical trials with carbonisation in Mali following the so-called "3-drum" procedure. The carboniser used is made of recycled materials (drums, sheet metal, etc.) It has two parts: the main body which is cylindrical in shape and the conical cover which is fitted with a chimney at the top. It is made of 3 drums, 2 angle bars and 2 metal sheets (1 Ø mm). The chimney has a removable cover. The carboniser is easy to manufacture, mobile and transportable, which allows the producer to move depending on where raw material is available.

The "3-drum" carboniser in action

Carbonisation using the "3-drum" technology is similar to the technologies currently used in the Sahel.

Depending on the quantities of charcoal to be produced, artisanal or semi-industrial procedures can be used to make charcoal. Below we lay out the main forms of semi-industrial production.

Round briquettes

The small coals (dust) are mixed with a 10 % molasses solution and rotated slowly. Gradually small balls form, measuring 4 – 5 cm in diameter.

They are then placed in the sun to dry for 3 days.

Forming balls with the molasses solution

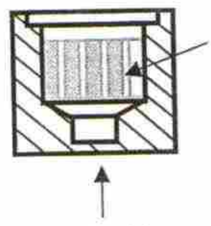
Cubic briquettes

The small coals are mixed with a molasses solution, and then poured into a mould. The mixture should be compressed using a board or plank. Once removed from the mould, the briquettes should be placed in the sun to dry for 3 days.

Cubic briquettes made by adding molasses

Briquettes for the Yotan stove

Aluminium oxide is used as a binding agent. The briquettes are cylindrical in shape (with a diameter of ca. 12 cm) and are perforated with vertical holes running the full height of the briquette to ensure a good oxygen supply during combustion. One briquette of this type will burn for between one hour and one and a half hours. They are not commonly used to date in Africa. (The Yotan stove comes from Asia and is most commonly found in China at present.) The Yotan briquettes could equally well be made using molasses as the binding agent (see above).



air supply

Charcoal for the Asian Yotan stove

A binding agent is needed to stick together the small coals and form briquettes. Molasses are a good binding agent, especially during the dry season (cheap, available in large quantities in the sugar refineries for ca. EUR 20/tonne). To avoid fermentation and the subsequent destabilisation of the briquettes, the fuel should be stored somewhere where it is sheltered from the rain and protected from humidity.

Other possible binding agents include clay, starch and rice straw.

Straw briquette
(photo société BASA)

Traditional charcoal stove
(photo Pro-Natura)

Typha briquettes (Pro-Natura),
(photo Pro-Natura)

Scale of Manufacture

The advantage of producing briquettes in numerous small units is that this provides for decentralisation at village level. The small coals could be delivered in drums to small enterprises which would produce and market the briquettes.

Large-scale production on an industrial or semi-industrial scale has the advantage of standardising the product and would probably guarantee a more regular supply of the market. But, this option would generate significantly fewer jobs, and could result in the emergence of monopolies.

Non-Fuel Uses

Using Rhizomes

Two main raw materials can be extracted from the rhizomes and used:

- **Starch**

About 30 % of the dry matter of the rhizome consists of starch, which can be used in several ways: for human food and animal fodder, in the production of important secondary products including the resins used by laundries and dye shops.

An alcohol can also be extracted that can be used as domestic fuel (gel fuel), a raw material in industry or as motor fuel.

- **Fibres**

About 60 % of the rhizomes are made up of fibres. These fibres have special properties: they are long, strong, resistant and can be used in bag and rope production.

Typha rhizomes

Rhizome fibres

The waste materials from the fermentation process can be effectively used by farmers as fertiliser.

Use in Construction

Typha can be used in construction on its own or in conjunction with other materials such as clay.

In Western Africa, straw is already widely used in clay construction, especially in rural areas. *Typha* straw could easily be used in a similar fashion on a large scale.

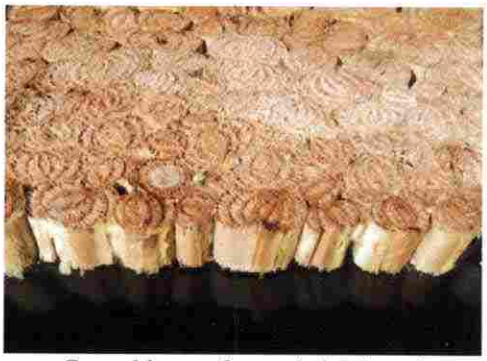
In Europe there is an expanding market, which might open up the possibility of exporting *Typha*-based construction materials. In conjunction with clay, *Typha* can be used to make a wide spectrum of construction materials. For instance, by selecting stems of different lengths, and compressing these with clay, a material very like cork can be produced. Other materials can also be produced with better electrical or heat conductivity.

Most recent findings indicate that *Typha*, because of its special properties, can be used to produce a whole range of construction materials comparable to wood-based materials. For example, the following products could be produced for local sale or for export: beams, load-bearing elements, sheets or plates, insulating board, etc. (see photos on the next page of *Typha*-based products).

These basic materials can be used competitively in modern housing and industrial construction.

Rods made of *Typha* leaves

Typha construction timber
(bonded stems)



Central layer of a sandwich board

Solid *Typha* insulating boards

Insulating board

Insulating material

Typha as Mulch

The Sahel countries are currently facing food insecurity, partly due to soil degradation and reduced soil fertility. *Typha* biomass could be used as mulch. Spread over degraded soils it would reduce exposure to the sun, and would be gradually transformed into humus, helping to restore soil fertility. Soil erosion and the drying out of the soils could be combated effectively at low cost, using mulch made of shredded *Typha* leaves.

CONCLUSION

Typha can be used in several different ways.

- As a source of domestic fuel: it is easy to carbonise *Typha* and the charcoal obtained is of a high quality. It could replace charcoal made of wood, which would reduce pressure on forest resources.

- As a construction material: it has interesting thermal properties which could also it to replace traditionally imported materials such as posts, cork tiles, etc.

- *Typha* can also be used for human food and animal fodder, and as a material for craftsmen and women (basket-making, ropes, etc.).

All these uses would allow us:

- to improve the balance of trade of the countries concerned (reducing imports of construction materials and exporting new *Typha*-based products);

- to create numerous jobs, especially in rural areas, thus helping to reduce poverty and produce ecologically sound, bio-degradable products.

Finally, large-scale use of *Typha* will do much to help protect the ecosystems of the rivers Senegal and Niger, by allowing us to better control the spread of the plant.

Typha australis in the Senegal Valley