Promoting woodless construction in the Sahel

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Foreword

The World Habitat Award for innovative housing solutions was presented to Development Workshop in 1999. This recognized the value of the organization's work in the promotion of woodless construction in the Sahelian area of Africa over the last 20 years. Woodless construction is a way of building roofs without using wood and it seeks to meet the growing human need for more and better shelter, while at the same time helping to counteract the growing environmental problems of the area.

This article draws on the work of, and publications written by, Development Workshop staff and colleagues.

An introduction to the Sahel

The word Sahel derives from the Arabic word meaning shore or edge, and it is a semi-arid region of Africa, immediately south of the Sahara Desert. It stretches from Mauritania in the west to Ethiopia in the east (fig. 1).

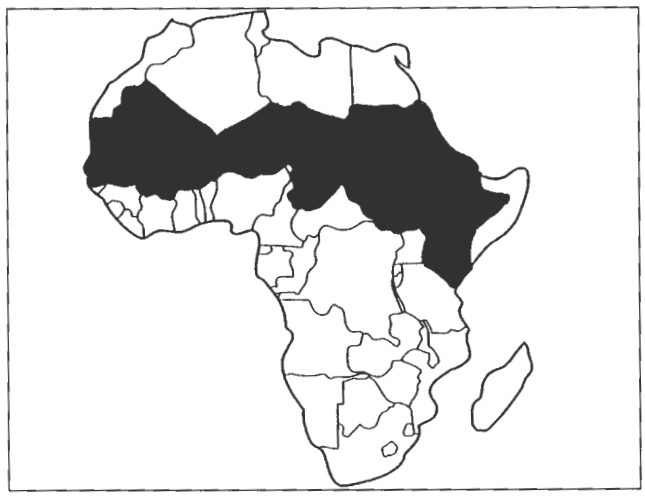

Fig. 1: Location of the countries of the Sahel in Africa.

The Sahel has been blighted by years of drought. The major cause of environmental degradation however is over-consumption of timber by man, both for fuelwood and for building. Many tree species have disappeared from the region. In some areas whole forests have disappeared. Oral histories recently recorded by older people living in the Sahel provide a vivid image of their changing world.[1] Typical of these is Kouré, aged 65, from Takiéta in Niger:

"Trees are crucial to our life. We feel their loss in different ways: soil fertility is reduced because there is less leaf litter and wood ash, and wood for fuel or construction is lacking, as are the leaves, bark and roots variously used to treat specific ailments. The drought has destroyed much Sahelian vegetation, killing people and animals in large numbers. Many trees have gone because of excessive cutting for fuel and for the construction of roofs, fences, sheds, mortars, pestles, hoes, ploughs and works of art. Forty years ago, the colonial government was aware of the negative impact of deforestation and introduced a law requiring people to have special tree cutting permits. However, the Department of Water and Forests and the Department of Fauna and Flora only began enforcing it two years ago."

Haoua Talba Hadj (age not known) from Mara in Chad tells a similar story:

"One thing we do not sell is firewood. We use all that we can get for cooking. If it was only us using the wood there would still be trees around us, but people come from far afield and destroy the vegetation. They come from as far away as Farcha or N'Djaména on the backs of donkeys, in lorries or pushing carts, piling wood on to their various forms of transport. This is what has turned the land into desert. In an attempt to stop the practice a number of forestry guards have come to live with us in Mara."

The region varies from desert-like conditions in the northern part to savannah in the south. The climate of the region is characterized by low rainfall and a broad temperature range. Rainfall varies from less than 100 mm per annum in the north to 800 mm or more in the south. Rain, when it comes, is usually in the form of short heavy storms with 80 to 100 mm in a single storm not being unusual. Temperatures can rise to over 40°C in the day and drop at night to near freezing. These extremes are less marked in the more humid southern part of the region. The winter period in December and January can be uncomfortably cold in the desert regions. For the local population this excessive cold can be more of a problem than the excessive heat of the summer months.

The north of the region is inhabited by Tuareg nomads, while in the center and the south there is greater diversity of ethnic groups and activities and a more sedentary life style. This is one of the poorest areas in the world with few natural resources. For many families disposable cash is virtually non-existent and many activities are undertaken in a spirit of mutual self-help, especially in rural communities.

The average population growth rate in the region is between 2.5 and 3.5 percent per annum and as high as 7 percent in the urban areas. In 1975, for example, 11 percent of the population of Niger lived in urban areas. By 2000 this has increased to 20 percent and is predicted to rise to 38 percent by 2025. Similar figures apply to Chad. Burkina Faso has seen an increase from 7 percent to 37 percent in urban living in the same time period, with a predicted level of 67 percent in 2025.[2] The rate of migration to the towns has increased in recent years as drought has driven people from the land and lorry loads of wood and branches are daily being taken into the town for sale as fuelwood. Pressure on timber supplies is particularly acute in the urban-rural fringe.

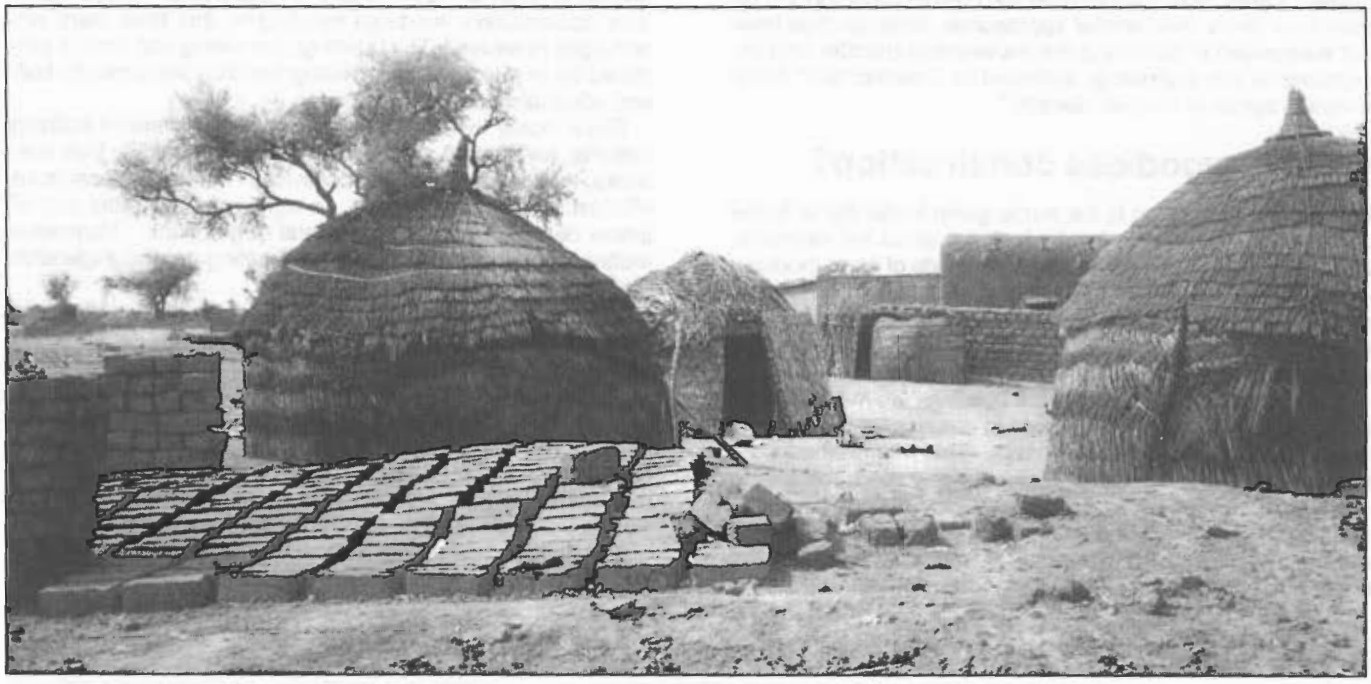

Fig. 2: Traditional rural housing with bricks for woodless construction drying in the foreground.

Housing in the Sahel consumes large quantities of organic materials, including grasses, straw, branches and tree trunks. In the rural areas, housing is typically small round mud huts (fig. 2) with grass roofs or earth block houses with flat earthen roofs supported on large timber beams. A series of punishing droughts and the over-consumption of wood and organic materials over the past 20 years has led to a depletion of local wood supplies. In Mali, for example, a 30 sq.m building would typically use 60 m of timber beam and 12 cu.m of branches in its construction. An average of 14 tree trunks would be required to build the roof alone. When good quality timber for construction became extremely scarce and expensive, people turned to using poorer quality timber with less durability. This stop-gap solution however has only served to reinforce the problem by speeding up the rate of timber consumption even more, since this poorer quality timber needs to be replaced much more frequently. The depletion of forests and woodland has led to soil erosion and progressive desertification.

With the depletion in timber resources in the area, the local people have been unable to find large timbers or tree branches to build in the traditional ways. Even supplies of grass are becoming harder to obtain. Nor can many people in the rural areas afford the imported alternatives of corrugated iron sheeting or cement. In the cities more expensive construction materials can be seen, including sand cement blocks for walls and occasionally fired bricks and stone. Roofs are covered with either corrugated metal sheets, reinforced concrete or clay/concrete tiles.

The use of earth in construction

Earth was one of the first building materials used by man and was the most commonly used building material in Europe until the middle of the 19th century. It is still widely used elsewhere in the world and has the advantage that it is locally available and can be obtained at little or no cost.

Timber is the material traditionally used to provide the framework for roof construction. Where this is not available, a frequent response is to build vaulted or domed roofs. Examples of this include igloos made with compacted snow, the reed structures used by the Marsh Arabs in Iraq and the earthen domed and vaulted roofs developed over 3,000 years ago in the ancient Nile Valley Kingdom. Similar techniques were later developed in present-day Iran and its neighboring countries as well as in China. Variations on these techniques are still in wide use in these countries. The dry conditions in which these techniques emerged are similar to those which prevail in the Sahel today.

The need to find affordable and sustainable building solutions in the 20th century has encouraged a renewed interest in earth vault and dome roofing. This revival started in 1941 with

the work of the Egyptian architect Hassan Fathy. Members of Development Workshop (an NGO concerned with developing and promoting sustainable shelter approaches) worked with Fathy in the early 1970s and subsequently in Iran and made use of the sophisticated and diverse Iranian vault and dome building techniques, building both with fired bricks and with stabilized and unstabilized earth bricks. Development Workshop's experience in Egypt and Iran lies at the origin of what was to become the woodless construction program in the Sahel.[3] Other NGOs concerned with development in the region have since used similar approaches, although they have not succeeded in achieving the widespread transfer and acceptance of the technology achieved by Development Workshop's program in the past decade.[4]

What is woodless construction?

Woodless construction is the name given in the Sahel to the construction of buildings in which all the structural elements, including the vault and dome roofs, are made of hand-moulded unstabilized mud blocks. Not only does this method of construction use no wood, it also requires no presses or cement to make the bricks, nor do they need to be fired. Woodless construction at Iférouane can be seen in figure 3.

The walls and foundations of the buildings are made of large earth blocks which are hand-made in rectangular moulds and left in the sun to dry for a few days. This is a method well-known in the region and the blocks are manufactured on the outskirts of most settlements. The roofs are domed or vaulted rather than flat and are built using small earth bricks. The roofs are built without using any wooden formwork and thus the entire structure – walls, lintels and roofs – is built with locally available earth. The bricks are laid in a mud mortar and the finished building is rendered with local renders. Very little special equipment is needed for the construction.

Woodless construction suits the local climate, where it rains only infrequently but in short, intense showers. Smooth angled curves and large gutters help to ensure a good flow of water off the roof so that there is no water damage, even in periods of very heavy rainfall. In the exceptionally heavy rains of 1994 there was damage to housing throughout the Sahel; 18,000 houses in Niger alone collapsed. Virtually all of the 500 woodless construction buildings existing at this time were undamaged however.[5] The buildings are strong and have a predicted life of many years, providing that they are correctly built and adequately maintained.

Since locally available earth provides an abundant building material, and people are familiar with hand-moulding their own bricks, the use of woodless construction methods presents an affordable roofing technique, as well as reducing the rate of timber depletion and environmental degradation. Alternative roofing materials of cement or tin sheeting are too expensive for the vast majority of people to use.

Other advantages of the woodless construction method are that the roofs do not collapse unexpectedly (a common problem with the flat timber roofs), the houses are cooler in the hot season and warmer in the cold season, they are cheaper to build than houses with good quality wood and they last longer. The houses can also be seen to be prestigious and confer status in the villages. The need to regularly replace the roof timbers is also avoided, thus saving time and money as well as the effort of obtaining scarce supplies of timber.

The building technology suits both the formal and informal building sectors and is equally suitable for building hospitals,

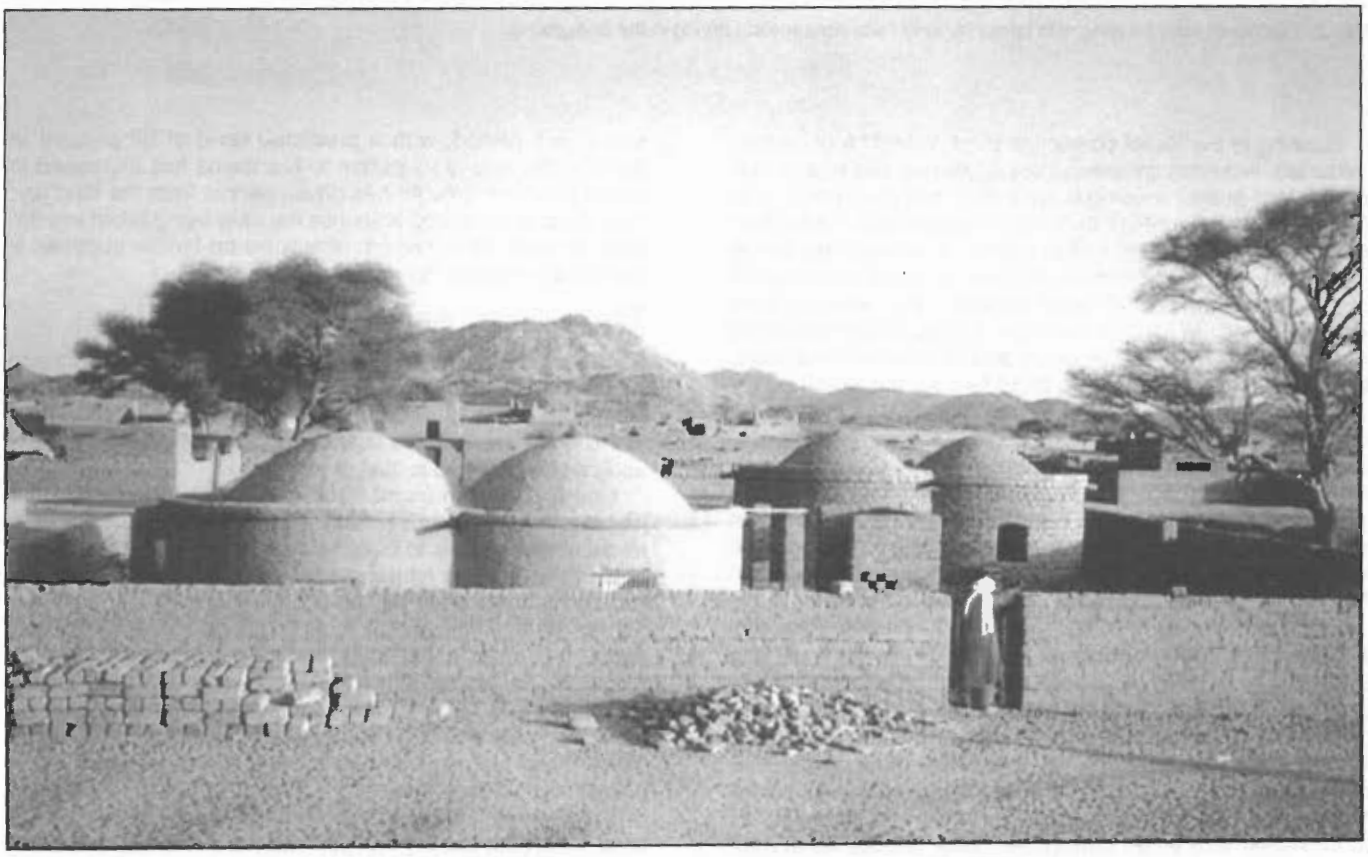

Fig. 3: Woodless construction at Iférouane.

mosques and offices as well as simple shelters and larger houses (figure 4 shows a hospital and figure 5 an office). Single domes can be used to cover square as well as round spaces and vaults tend to be used to cover rectangular spaces. The combination of several vaults and domes can be used in simple or more complex combinations to satisfy a variety of building requirements. These building forms can be easily mastered by masons who have received basic training (fig. 6).

Many non-governmental organizations working in the Sahel, as well as governmental organizations, are now using these construction methods for buildings they need in the rural areas. Active support has been received from a wide range of agencies working in the Sahel, including the World Conservation Union, the Red Cross, the International Labour Office, World Vision, SOS Sahel, the US Peace Corps, and the European Community. The army in Mali has used woodless construction to provide accommodation for its soldiers. Woodless construction methods are also used to build communal granaries, which effectively act as a banking system by keeping each farmer's supply of grain until he wishes to sell or use it.

In addition to providing decent and durable shelter, the woodless construction approach also brings economic and social benefits, since the income-generating opportunities provided by training masons in the technique are long term.

Fig. 4: A maternity hospital near Niamey in Niger built using woodless construction methods.

Fig. 5: Office accommodation for an NGO in a woodless construction building.

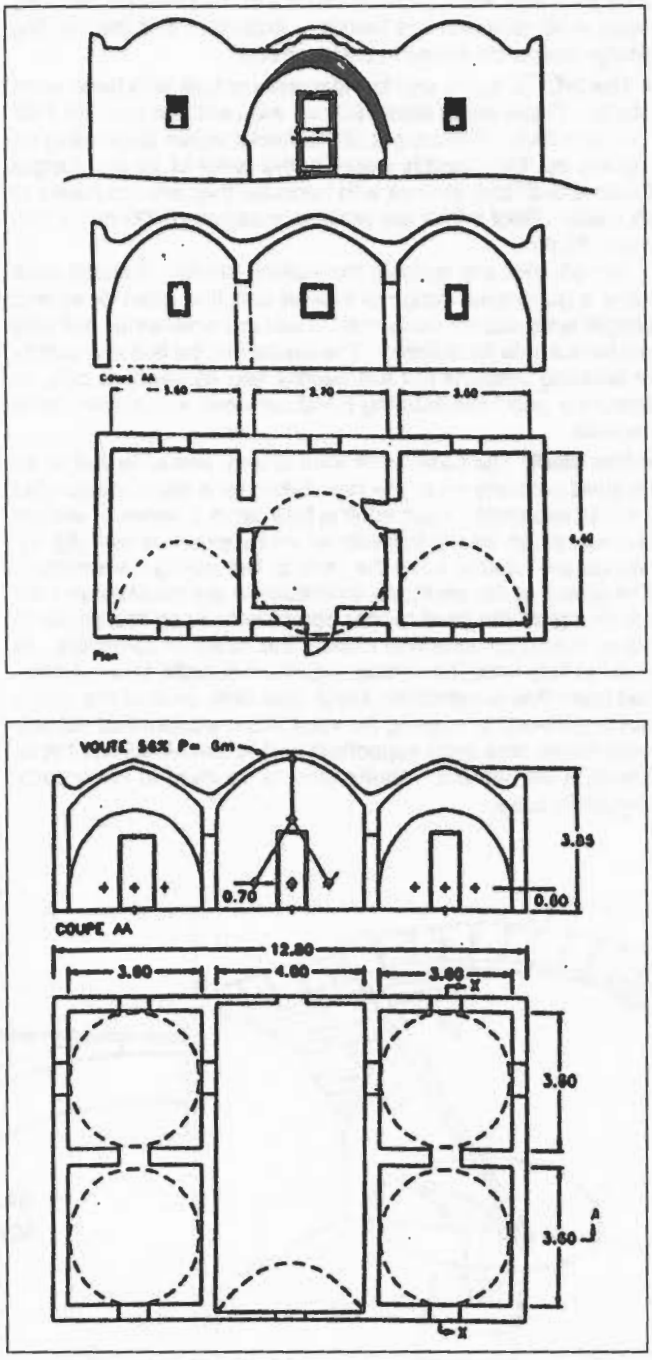

Fig. 6: Combinations of simple vaults and domes.

Woodless construction technology

Building roofs with earth vaults and domes requires that careful thought be given to the rest of the structure, as well as to the site on which the building stands. Since the building is made entirely of earth it is important that it does not stay damp for a long time. A good site is therefore important as it needs to avoid river beds, floodable plains and marshy areas. It also should avoid areas where there are large cracks in the ground and unstable ground, such as sand dunes. Correct orientation of the building helps to ensure that maximum protection is achieved from the rain-bearing winds by making the surface of the building that faces the rain as small as possible. Excessive heating can also be reduced if the building is orientated on an east-west axis. Mud bricks are strong in compression and very weak in tension and it is therefore important that the building design keeps the forces in compression.

- **The bricks**: Walls and foundations are built with large earth blocks. These are at least 190 mm wide and are typically 110-120 mm thick. The weight of the bricks varies depending on density but they usually weigh in the order of 18 kg. Larger bricks are difficult to work with because they are too heavy to lift easily. Roof bricks are smaller, measuring 200 mm x 150 mm x 60 mm.

Not all soils are suitable for making bricks. Suitable soils have a good even range of coarse and fine grain sizes and simple tests can be performed to assess whether or not soils will be suitable for building. The bricks can be laid in a variety of bonding systems but are usually laid as headers only, to ensure a good overlapping bond between successive brick courses.

- **The vault:** The basic vault form is very similar to that of an inverted catenary – i.e. the form taken by a chain suspended from its two ends. Each vault is built up in a series of vertical courses which incline towards an end supporting wall (fig. 7). Strings are used to keep the vault in line during construction. The shape of the vault, the inclination of the courses and the stickiness of the mud mortar combine to keep the bricks in place during construction without the need for formwork. In order to help keep the vertical alignment straight, an innovation has been that construction starts from both ends of the space being covered. In building the vault, it is important that the outward thrust onto each supporting wall is contained and transferred to the ground. Vaults tend to be used to cover rectangular spaces.

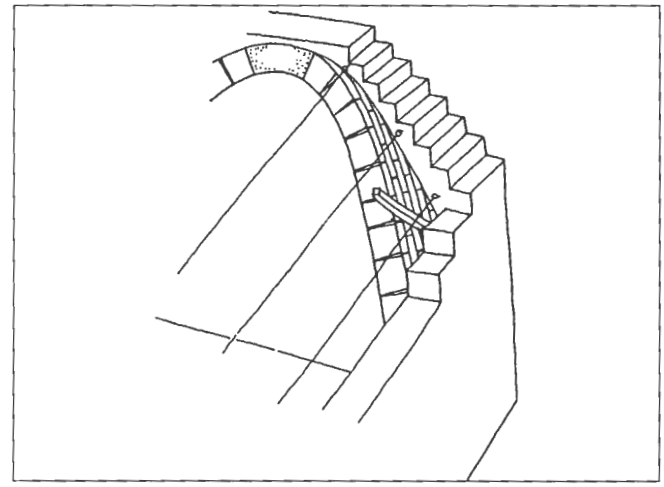

Fig. 7: Guiding strings follow the alignment of the vault, helping the builder to keep a good vault shape.

- **The dome:** Rather than use the hemispherical dome shape that was traditional to Egypt, the woodless construction techniques promoted by Development Workshop in the Sahel use a slightly more pointed dome form, which increases the height of the roof and allows one to position the start of the dome lower down towards the ground. This helps direct the forces in the dome towards the ground, and slightly reduces the need for thick earth brick walls. The position and angle of each brick in the dome is fixed by a wire or radial arm which rotates around a central post and this can be seen in figure 8. It is the displacement of the radial arm that makes the dome more pointed. Several domes together, or a combination of vaults and domes, can be used to create varied and interesting forms and interior spaces. Single domes can cover rectangular as well as round spaces, and even irregular shapes.

Both domes and vaults are covered with a second layer of bricks, laid flat in mortar, which increases water protection. Experience has shown that not laying this second layer of bricks is a false economy, as it is important in ensuring protection from water penetration. Secondary vaults and domes can be built to reduce the volume of infill required to create flat roofs (fig. 9).

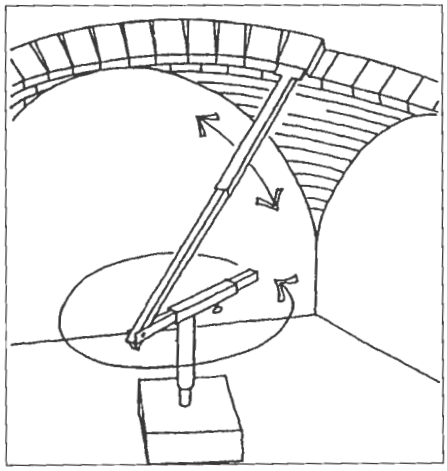

Fig. 8: A radial arm is used to locate every brick in the dome.

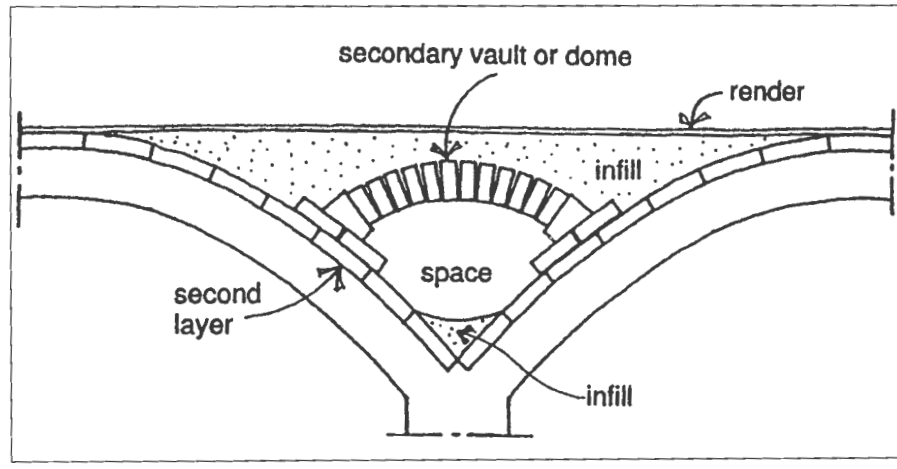

Fig. 9: Secondary vault domes reduce the volume of infill required to create flat roofs.

• **Walls and foundations:** The walls that support the roof need to be thick enough to take the outward thrust of the roofs. The thickness of the walls therefore depends on the design of the roof and the size of the rooms. For a small dwelling with rooms no larger than 3 or 4 m wide, it is common for walls to be about 400 mm thick. It is important that the bricks are laid with care using a bonding pattern that avoids vertical joints linking one course of bricks and another. The bonding pattern depends on the size of brick used but increasingly a "headers only" bonding pattern is used. The foundations can be made with the same bricks as the walls, providing that they are kept dry. A prime concern is to ensure that rainwater flows quickly away from the building.

• **Parapets and water runoff:** At the edge of the roof, the parapets and the infill of the valleys between roof shapes combine to play an important role in controlling the flow of water off the roof. It is important to ensure that the water does not flow too quickly off the roof (or it will erode channels in the mud mortar and bricks) or too slowly (so that the water has time to penetrate). It is important to use large open gutters. Gutters made out of round PVC pipes are not adequate as they block easily. Banking up compacted soil around the house is also important as it keeps water from collecting at the base of the walls where it can seep into the foundations.

• **Finishes and renders:** Any interior finish can be applied according to the needs and resources of the owner. Cement plasters do not adhere naturally to earth walls, nor do lime and gypsum. Earth plasters, which may contain additives such as animal manure and straw remnants, have the advantage of bonding well with the earth wall and can provide a resistant render for several years, providing that annual maintenance is carried out. An earth plaster is recommended for the external surface of the roof, as it will be able to absorb moisture in its surface during a rainstorm, and allow it to evaporate when the storm is over. External cement plasters allow water to penetrate beneath the surface through hairline cracks but prevent drying out after the rainfall, thus encouraging a dangerous accumulation of moisture in the earth roof. Water resistance of earth plasters can be increased by using additives, such as vehicle sump oil or bitumen products or tannin extracts from local trees.

The woodless construction program seeks to be popularly accessible and has to ensure that:

- genuinely local materials are used and there are enough of them;
- the production and use of the building materials differ as little as possible from existing local practices;
- as little specialized equipment as possible is used;
- the techniques used are relatively easy to learn and are affordable to low-income groups;
- the techniques used are durable and flexible to meet local climatic, social and economic needs;
- the construction process helps develop income-generating opportunities for local people, using local materials as well as restoring pride in the local building quality.

Introducing woodless construction technology to the Sahel

At the invitation of a Canadian supported local environment project in Niger, "Projet Tapis Vert," the first demonstration of woodless construction in the Sahel, was made in 1980 by Development Workshop, a small Canadian and subsequently French registered NGO, concerned with developing and promoting sustainable solutions to housing problems. The techniques, previously unknown in the area, were introduced in order to provide a viable, affordable and accessible alternative method of building in the region that reduced wood consumption. The specific objectives of the woodless construction program are[6]:

• to introduce building techniques to the local population which reduce dependency on non-local resources;
• to provide an alternative building technique using a familiar local resource as local organic sources become scarce and costly;
• to provide training to a sufficiently large number of masons to achieve "cruising speed," i.e. a resource which is both sufficiently visible to be in demand and sufficiently competitive to avoid over-pricing;
• to train local trainers from amongst the best of the masons, which both increases local confidence and credibility and provides a sustainable future for the techniques;
• to increase the generation of local income through the training and employment of local masons (and trainers) and through more organized use of local materials and transport;
• to improve traditionally female income-generating opportunities (pottery, soap-making, etc.) through provision of suitable buildings and to involve village women in decision-making processes on local building needs;
• to raise awareness at all levels of the relationship between building and environmental resources, health and local income generation;
• to strengthen the emergence of civil society by using local groups wherever possible as vectors and by encouraging the creation of local non-profit organizations or masons' groups to "market" the techniques.

After initial demonstration by Development Workshop for the "Projet Tapis Vert" near Filingué, Peter Tunley, future Development Workshop associate then working for the "Projet Tapis Vert," was invited in 1983 by IUCN (the World Conservation Union) and WWF to provide offices, accommodation and public facilities as part of their conservation program in the Aïr Ténéré region of northern Niger. Tunley took the basic woodless construction techniques and began to adapt them to the Sahel context. Masons were trained on the job as they worked on these programs and, on returning to their home villages, helped to spread the technology out from the region. Contact was maintained with Development Workshop, which progressively provided additional support to the Aïr Ténéré project through the late 1980s, and laid the foundations for what were to constitute the future "Woodless Construction" programs in Niger, Mali and later in Burkina Faso.

The process of introducing change is a slow one, even when there is an urgent need to consider new methods. Any innovation, however apparently viable, cannot be assumed to be acceptable. It needs to be assimilated into a local culture, adapting to local needs and conditions over time. The poorer the community, the less people are prepared to take risks with unproven new ideas and it takes time for a new approach or product to achieve local acceptance. Transfer of technology traditionally takes many years with a building practice transferring from father to son or master builder to apprentice. This process has to be speeded up if urgent needs are to be met and careful thought has therefore to be given to the training process.

Introducing woodless construction in the Sahel has been, and remains, a process, rather than a project. The first woodless construction activities in the early 1980s provided on-the-job training for a small number of local masons. In this early period, the middle-eastern techniques to suit local skills were adopted to suit the local conditions. This was mostly thanks to Development Workshop associate Peter Tunley's collaborative work with local masons in northern Niger. This work

provided the nucleus from which regional activities have grown. There has been little resistance to the technology once people have the time to assess it, since there are the obvious advantages of being cheaper than modern material alternatives and longer lasting than "traditional" techniques, as well as providing a good quality house. Local masons play the most important role in spreading the woodless construction technique and on-going technical and marketing support is provided for them by Development Workshop. The process of introducing the technology can be summarized as follows:

- Assess new areas for their potential.
- Build demonstration buildings.
- Offer training opportunities to local masons.
- Erect woodless construction buildings for local people as part of the training process.
- Once training is over encourage each mason to start work, either by himself or in a small team.

As a result of this process it has been found that a local demand gradually develops and spontaneous construction begins.

Adapting woodless construction techniques to the local context has been an on-going process with modifications introduced to make it more acceptable to local building practices and needs. In particular modifications have been introduced which make the techniques easier to learn and use, as well as tuning them into local needs and expectations. These will vary from place to place and therefore flexibility is important. The main changes introduced include:

- changing brick laying to "headers only";
- using the brick itself as a unit of measurement;
- using a wire mud brick saw to trim openings which can simplify the use of complex bonding methods;
- drawing the curve of the vault using wires;
- starting vaults from both ends using guiding strings stretched from one end to the other;
- displacing the radial arm to an off-center position so as to give a steeper curve to the profile of the dome;
- using wide open gutters that cannot get easily blocked;
- using secondary vaults and domes to infill in valleys if a flat roof is required.

Good practice in encouraging dissemination

The experience of Development Workshop in its work with woodless construction has identified good practice for encouraging good dissemination.[7] This can be summarized as follows:

- **Consider all options and remain flexible**
  - *build a small demonstration building* – this helps to obtain local reactions and to assess how the woodless construction techniques will work in the local context;
  - *take your time* – the worst mistakes come from trying to go too fast;
  - *avoid building too big or too much* – masons should be given clear guidelines on what they can realistically build.
- **Make the techniques respond to local needs and expectations**
  - *offer flexible choice of space* – a choice of roofing combinations can be provided to cover different sized spaces;
  - *listen to the voices of local people and react to their ideas*;
  - *suggest different levels of owner contribution* – this helps the technique to be affordable to those on low incomes;
  - *encourage variety in decoration* – this encourages local styles and opportunities for personalizing a dwelling;
  - *propose options for reducing weathering* – providing a range of options to suit all pockets and tastes;
  - *inform clients about the wide choice in the quality of finishings* – these can be varied from very simple to very high quality.
- **Provide training in different localities**
  - *use local language for training programs*;
  - *provide easy to understand manuals* – even where literacy is poor, trainers are talked through the next day's work by a literate team member, and the capacity of trainers depends greatly on their own sound learning.

Evidence that the technology has been locally accepted can be found in the extent to which there has been voluntary take-up of the process by local masons and local people without any involvement of an organized program or project. In a survey carried out in 1990, 10 years after the program had started, it was found that 20 percent of all the woodless construction buildings had been built spontaneously by local masons. Well over 1,000 woodless buildings were recorded in 1999 as having been built, although many more have been completed but are not recorded. The occurrence of spontaneous construction can be illustrated with an example from Iférouane in northern Niger[8] (fig. 10):

The process is labor-intensive and provides employment for

Iférouane is an oasis village lying in northern Niger which was the focus of several years of building demonstrating the woodless construction techniques in the 1980s. Tuareg rebel activity in the area meant that all external support had to be withdrawn in 1991. On a recent visit to the area after several years of isolation it was found that nearly all sections of the population were using woodless construction techniques. The 14 trained Iférouane masons had organized themselves into two teams and their income had risen significantly, as had other income-generating activities such as brick making, laboring and transporting of bricks. Forty-three woodless buildings have been built ranging from small round huts to large villas and government buildings – a significant number in view of the size and economic condition of the village (fig. 3).

Fig. 10: Spontaneous construction in Iférouane.

many men who would otherwise be unemployed or underemployed. Over the years many alterations have been made to the original design and construction process in order to adapt to the needs and skills of both the masons and the users, and the local context. Confidence in woodless construction methods has come with the passage of time and has been led and sustained by local use.

The reasons for the successful take-up of the woodless construction approach are more complex than the simple logic of force of circumstances. Many failed projects have had a similar logic but still not been successful. The reasons for success also include the commitment and abilities of individuals, the luck of organizations being in the right place at the right time, better harvests compared to the drought years of the 1970s, providing relative security in local communities as well as the timely availability of funding to establish training programs. These factors all helped to support the basic imperative to find alternative building systems in the region.

Initial resistance to the program came from the belief that the buildings would not be able to withstand the heavy rainstorms. Experience has shown this to be unjustified. Heavy rains in 1994 and 1998 caused little damage to woodless construction buildings, unlike many of the buildings with timber-supported flat roofs, which collapsed due to the absorption of rainwater. Rain is not a problem, provided that it does not continue for a very prolonged period. Rain storms come with great violence for short periods and invariably from the east. The use of orientation to minimize the unnecessarily exposed roof profiles, good rendering and planting of shelter belts can all help to reduce the effects of driving rain.

Training

Traditionally, middle-eastern masons learned the skills of vault and dome building through a long apprenticeship which could last many years. This lengthy process is not now possible in the Sahel, where the depletion of trees, the rapidly increasing population levels and the increase in the sedentary life style all serve to lead to a rapidly increasing demand for dwellings.

As demand for skilled masons grew, it became necessary to provide dedicated training courses. Training opportunities had previously been provided directly on building sites where woodless construction was under way. However only comparatively small numbers of masons could be trained in this way and training was inevitably incomplete. With external funding from the Danish government, Development Workshop designed an eight-week training course for novice masons, and training began on a regular basis in 1992. The eight-week program consists of three weeks theory and practice on training structures and five weeks of closely supervised construction on simple dwellings. These short specialized training periods interspersed with time available for masons to find work on vault and dome building sites provide a good balance of learning in training and learning by doing.

At present Development Workshop co-ordinates major woodless construction programs in Mali and Burkina Faso whilst in Niger, in an important progression, the level of support has been reduced as local masons increasingly work on their own. Demand is greater than the supply of trained masons. Training is particularly targeted at those who already have mason's skills. Between 32 and 40 masons are trained on each course, with trainees working in groups of four under the responsibility of an assistant trainer. Each team is responsible for its own building, constructed for a genuine client in the community, who contributes labor and materials. The course is run by a local head trainer, responsible for theoretical teaching inputs, organizing demonstration work and supervising the quality of buildings (fig. 11).

Fig. 11: Masons on a training course in the techniques of woodless construction.

Today the training courses are run and managed by local teams who have been trained by Development Workshop. Paradoxically, in many cases greater problems are experienced with teaching wall building rather than roof building techniques, since roof building is a completely new technique and previous habits do not have to be discarded. As well as the practical skills it is important for masons to understand the nature of the forces exerted by the vaults and domes. The majority of masons return for additional training and revision courses and this is important in keeping the quality of work to a high standard and raising the standard and refreshing ideas already learned. Masons who show real potential are invited to be trained as team leaders or trainers. Training for local technicians and architects also needs to take place to ensure that there is a comprehensive understanding of the woodless construction method and its capabilities.

A trainer's manual (now in its 10th edition) has been produced for those masons who have become trainers of other masons and a video has been prepared by Development Workshop,[9] as well as building and maintenance manuals for the masons to use themselves. It is emphasized that manuals should not be relied on to learn how to build using woodless construction methods, but they are a useful reference and reminder for trained masons. Step-by-step guidance is provided with clear and easy-to-understand diagrams. Only minimal words are used by way of explanation in order to overcome the problems caused by language and illiteracy. The trainer's guide sets out the curriculum of the training program, specifying clearly what needs to be taught and the various practice structures that need to be built. It also includes the revision sheets to be used in the final stages of the course.

Training techniques are reviewed regularly as inevitably there are small technical and conceptual adjustments to be made to suit the technique to the earth available in the locality.

Trainee masons are selected in pairs with the aim that they should work together, as this is important in roof building. One builder on his own will not be able to build well. Wherever possible, masons are encouraged to introduce their own laborers on training and building sites as apprentices to ensure the continuity of sustaining the techniques locally. To date over 720 masons have been trained. Adaptation to local conditions also continues, to make the techniques ever easier to learn, stronger and better suited to various local needs.

A trained mason makes a good living, earning three times more than he would do as a laborer, as well as being a respected member of the community. Refresher courses for masons and easy-to-understand training manuals designed by Development Workshop are provided in order to be able to maintain high quality control of the dwellings being built. Emphasis is also placed on ensuring that families understand the need to maintain their dwellings.

Costs of woodless construction

The average labor cost for a house in a rural area is about $110 and the bricks are made from locally available earth at little or no cost if the family do the work. The client family can help to provide the building labor for the mason and this helps to keep costs down. The houses are paid for by the local people themselves – they are not built as part of a government or donor housing program. In rural areas the masons are often willing to work for barter (goats, food), especially if the house is for a member of their extended family or a friend. In an urban area the cost of building a woodless construction house is nearer $400 since the building materials have to be purchased and transported, in addition to the labor costs. Although these low costs mean that woodless construction is affordable to very poor people, it is not affordable to absolutely everyone living in the Sahel. The most destitute of the inhabitants have no goods with which to barter and no cash with which to pay a mason and therefore the simple straw hut is the only option available to them.

Comparing costs of different types of construction in the Sahel is not easy, since materials and labor may be obtained without cost or may both need to be purchased. The information in figure 12 below compares the comparative cost of different construction types in the private sector based on information obtained by Development Workshop in 1995.[10] It can be clearly seen that the woodless construction system is cheaper than the imported materials options and is broadly similar to the cost of traditional building with timber roofs. A distinction needs to be drawn however according to whether good or poor quality timber is used. If good quality timber is used the costs are higher than for woodless construction and there is comparable durability. If poor quality timber is used (which is by far the most common case) then the initial costs are slightly lower than for woodless construction. The poor quality wood however has very limited durability and will need to be replaced within two years, so the initial cost advantage is very quickly lost.

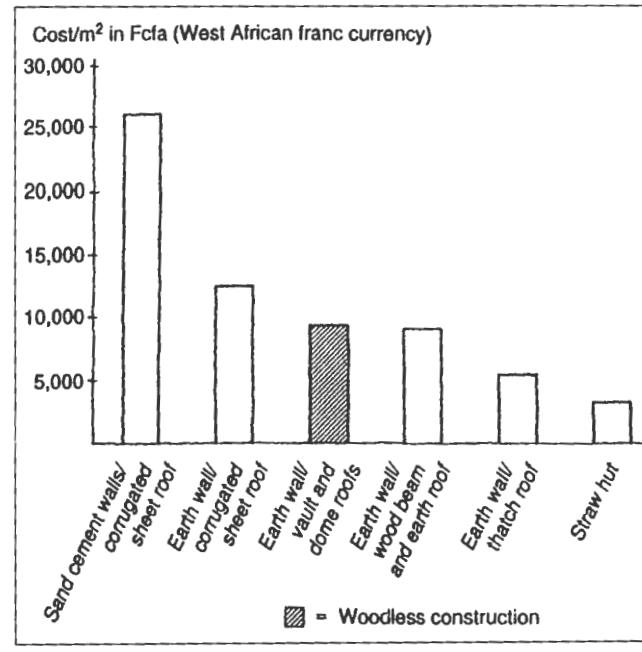

Fig. 12: Costs of woodless construction compared to other building methods.

Although the construction methods using cement and corrugated iron have good durability, they are not affordable by the majority of the population of the Sahel. Using woodless construction, it is possible to obtain the materials at little or no cost and also to provide much of the labor required for construction from friends and family. The only recompense required in this case is meals and a final celebration. The rapid increase in the cost of non-local materials and the increasing scarcity of wood mean that woodless construction is increasingly the only affordable option for the vast majority of households in the Sahel.

The cost of the training programs for the masons is grant-aided: external funds have in the past been provided by the Danish government and the World Conservation Union (IUCN), and currently the Danish and Burkina Red Cross are