

An update of DFID-funded shelter projects  
With IOM & partners, Heritage Foundation and HANDS  
in Southern Sindh, Pakistan  
October, 2012





The base: earth with lime bases withstood heavy rains in September, 2012 – which have encouraged locals of the value of including lime – the critical ingredient of this programme.

The “toe” is around 4’ (1.5m) width, and arises from the foundation which is the same width.

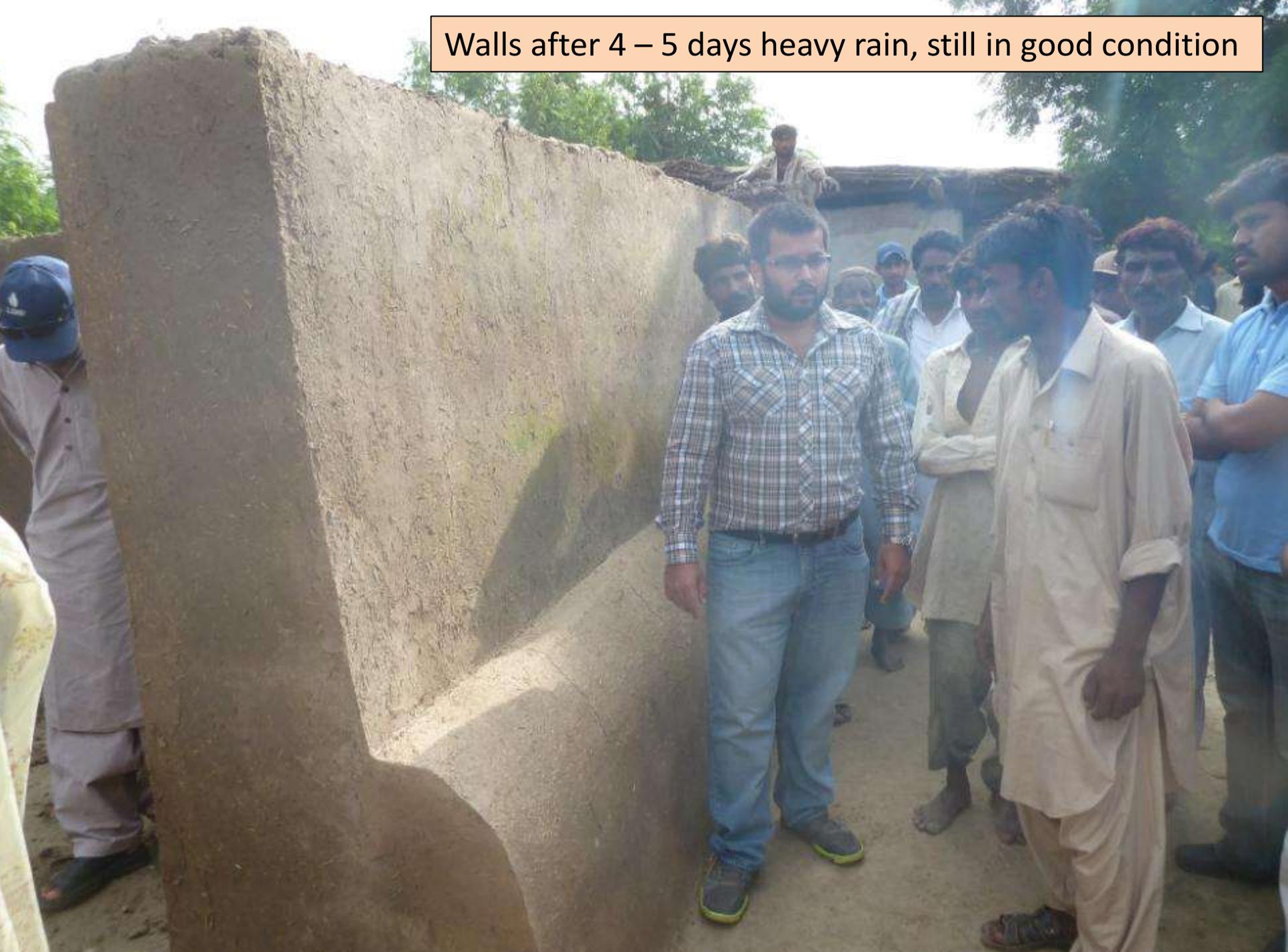
The walls rise up from these bases and will be around 18” (60cm) thick.

Once the walls are complete they will be further protected with a lime-rich render (external plaster).

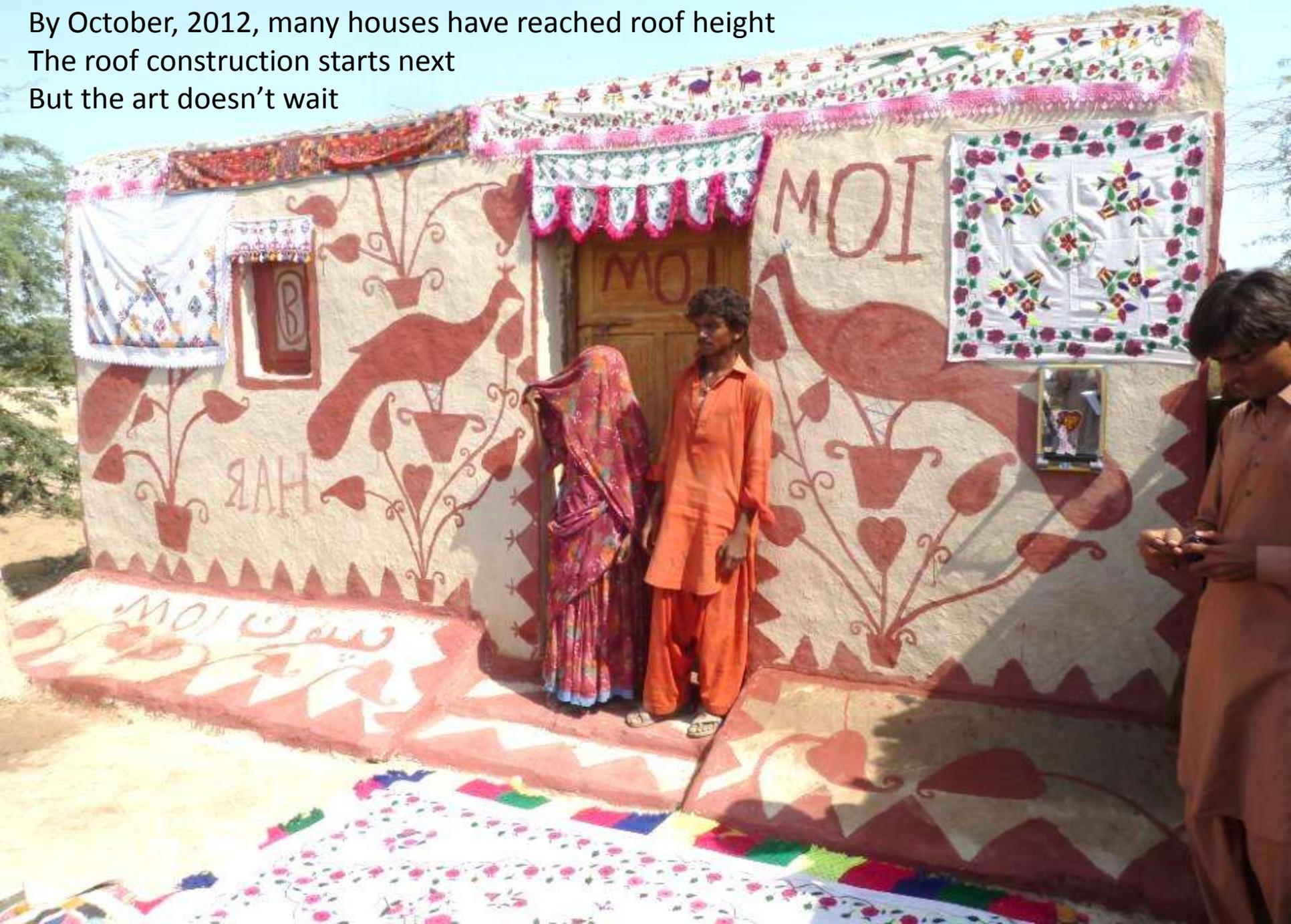
Many communities use this “cob” approach to building walls. A layer is added each day and allowed to dry, as show in picture. Lime has been included in the mix of the mortar used to build this wall. It is considered quicker than making bricks and placing them in rows.



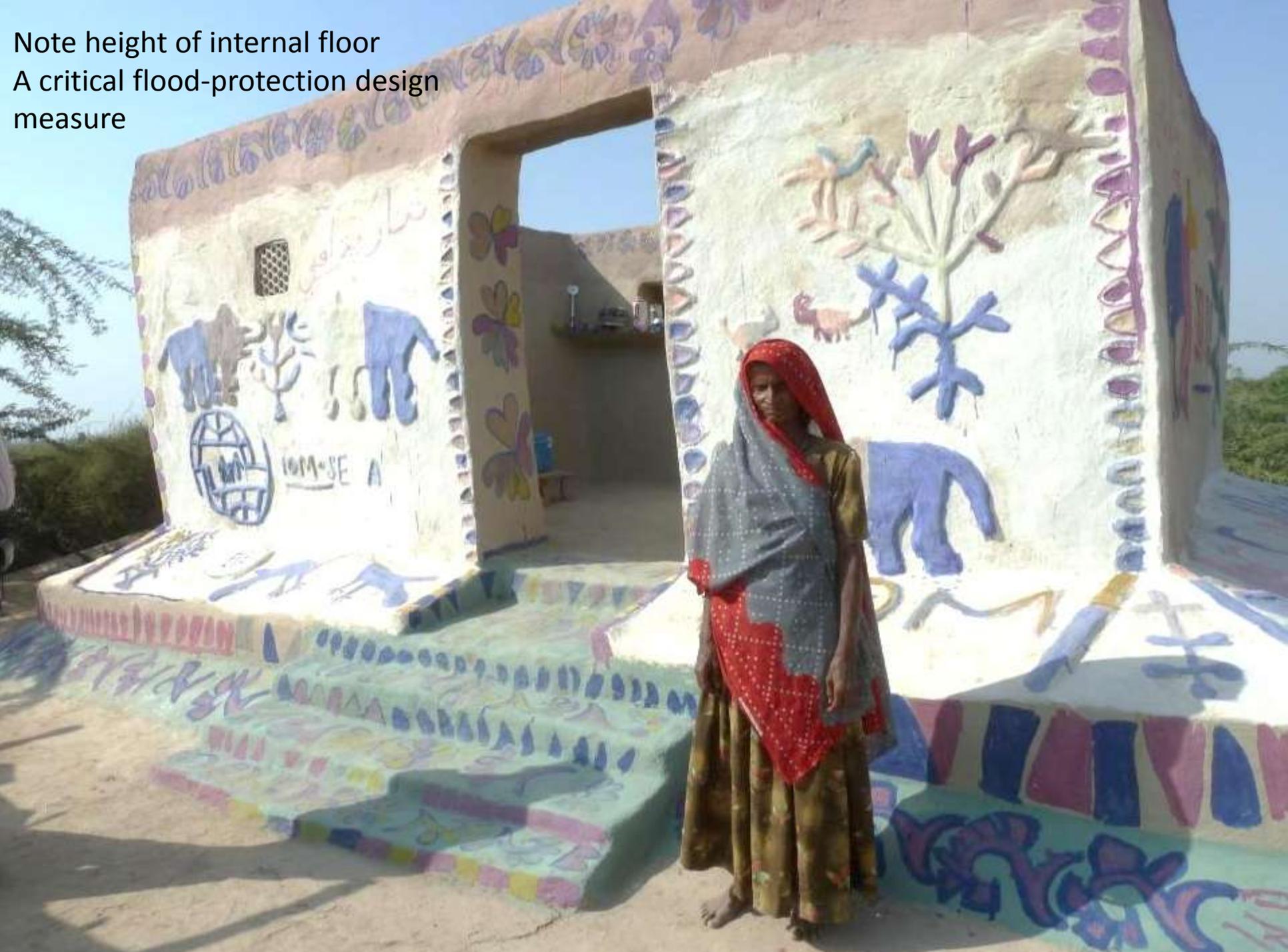
Walls after 4 – 5 days heavy rain, still in good condition



By October, 2012, many houses have reached roof height  
The roof construction starts next  
But the art doesn't wait



Note height of internal floor  
A critical flood-protection design  
measure





بھارت

The ring-beam as designed by Heritage Foundation, installed by IOM's partner NGO, SEWA. This is a lime-based concrete, using gravel bought in the local market; steel bolts are sunk into the walls to connect with the bamboo girders that will act as roof beams – making roof and wall an integrated structure. Note that a piece of split bamboo replaces the conventional use of reinforced iron bar.



Four pieces of bamboo are wired together to create a beam spanning the 4m room. Five such beams are used in total. The ring beam distributes their weight to avoid point loading.

Note the massive 18" (50cm) walls which reinforced with lime based plaster should be virtually indestructible.





S S



SEWNA

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**The massive “toes” rising above 4’ foundations of compacted earth and a 4” base of lime-concrete at bottom of 2’ deep foundation. The walls are 18” thick made of adobe or sun-dried brick and plastered with lime-rich mortar, often by women who take on much of the building process – especially when men are out earning money.**



No Comment!



Many communities in SE Sindh build these round “Chora” structures, traditionally. They form part of the cultural identity of these people and are very cool inside during the hot months. This model reconstruction in Tando Allah Yar by Heritage Foundation used earth-lime mortar and renders shows little sign of having been drenched by rain in early September, 2012.



**An alternative approach to reconstructing chora (roundhouses) by the local NGO HANDS which used fired bricks and cement-sand mortar. The Traditional roof structure and design is maintained.**

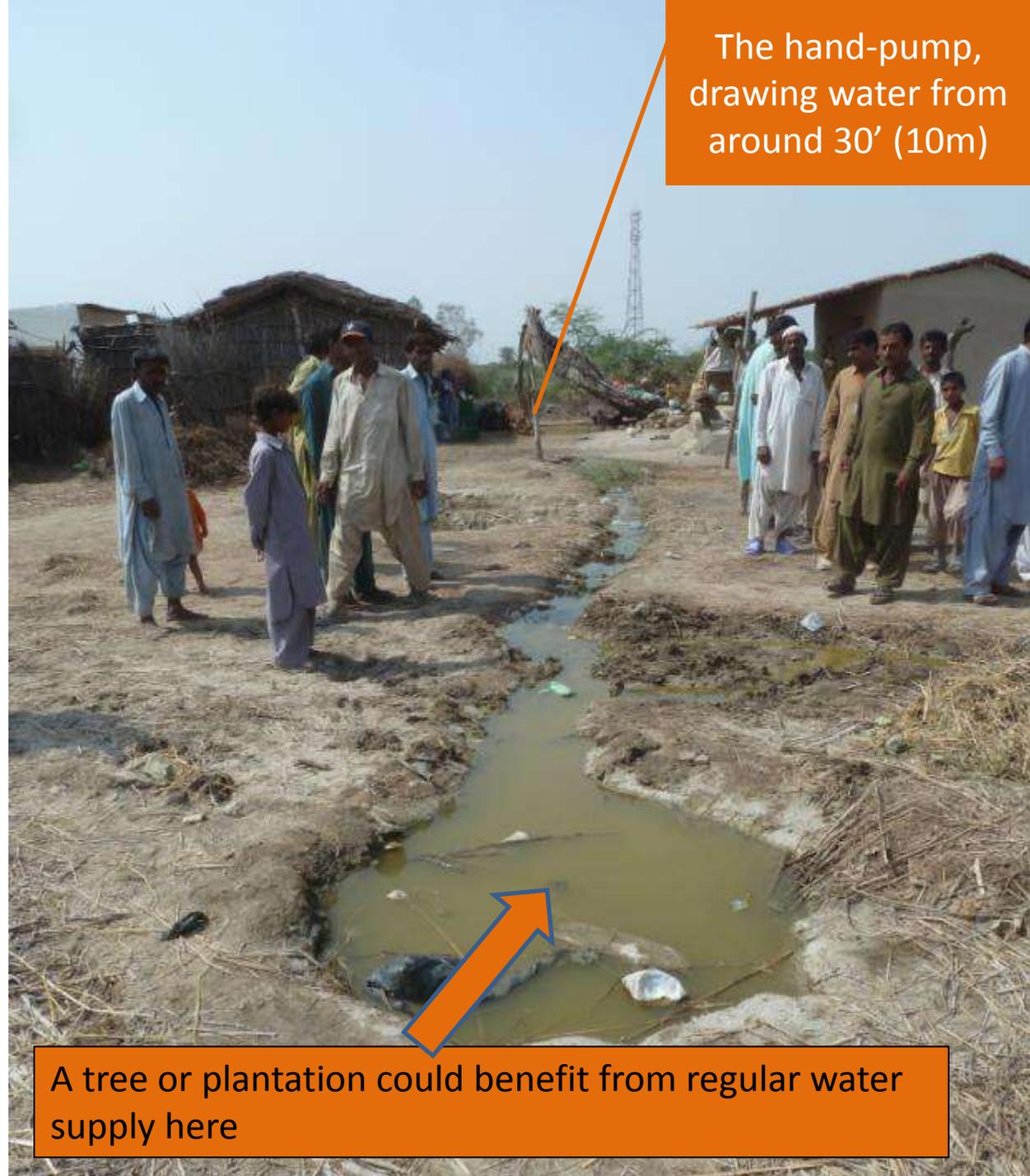


**Inside the chora. Despite the much thinner walls (less thermal mass) that result from using fired bricks, people say that the windows and door create more natural ventilation than traditional structures, and this brick version seems just as cool in hot weather as the old one.**

Water and sanitation remains a critical issues in most communities.

In many cases, such as shown in the picture, waste water from hand-pumps is wasted and allowed to create a public health hazard in communities.

This water should be used to irrigate a vegetable garden or a new tree plantation. Or even a bamboo plantation.



The hand-pump, drawing water from around 30' (10m)

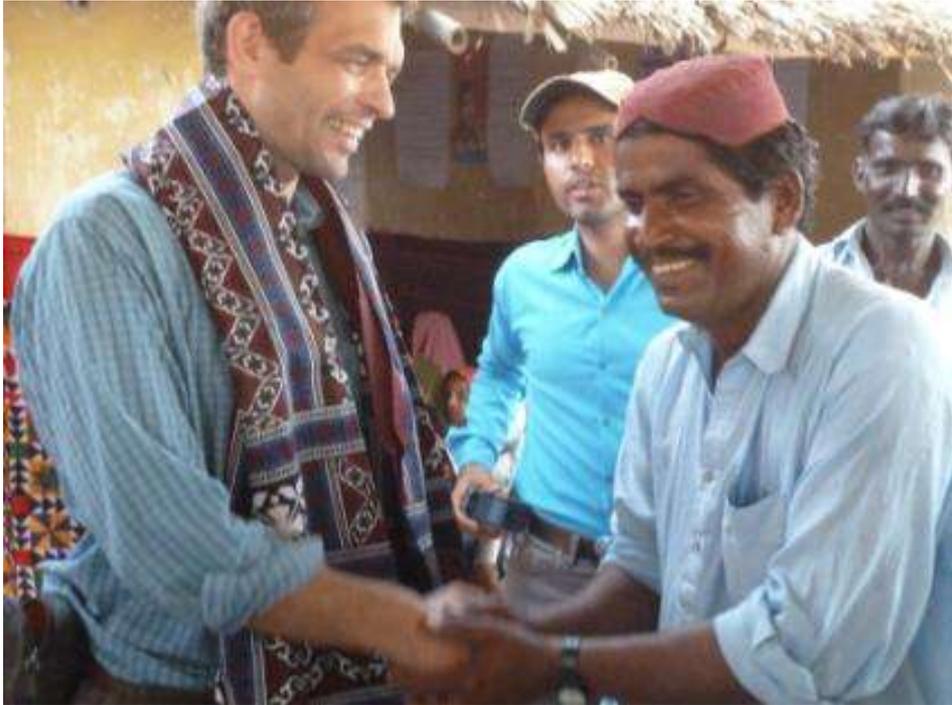
A tree or plantation could benefit from regular water supply here



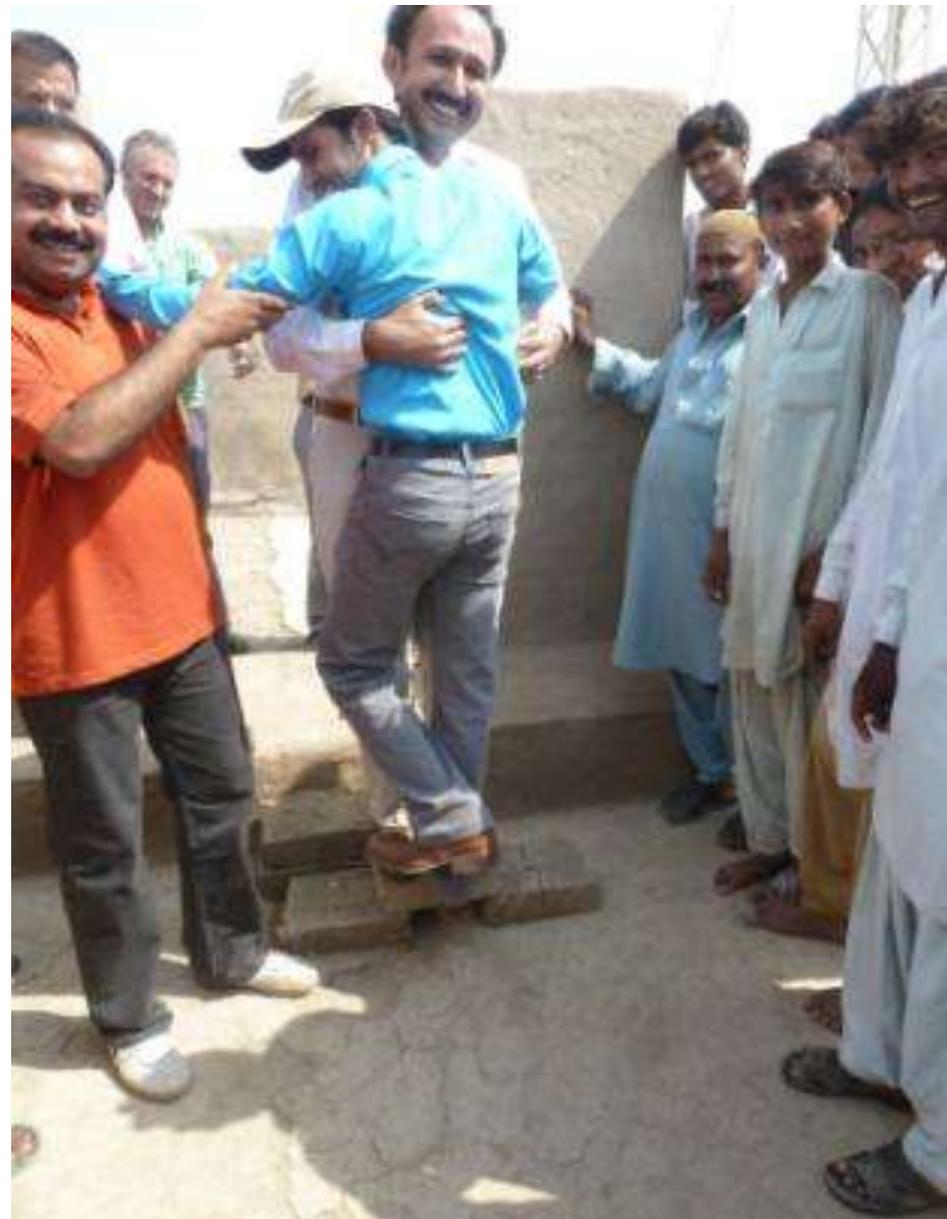
The “big debate” on steel beams: these are much heavier than bamboo composite beams shown earlier, their weight and “point loading” is harder to distribute with a simple and low cost ring beam; and they use much more energy to produce (and emit a lot of CO<sub>2</sub>) On the positive side they are readily available, quite cheap, are not affected by insects and can last generations.

Bamboo production is limited to in Pakistan and there may not be enough to meet demand, and can be prone to insects and mould if not properly protected. Yet bamboo can be cheaper, offer sturdy roof structures, can be connected more effectively to the walls, can be protected from mould and insects with proper treatment and is effectively a zero-carbon product.

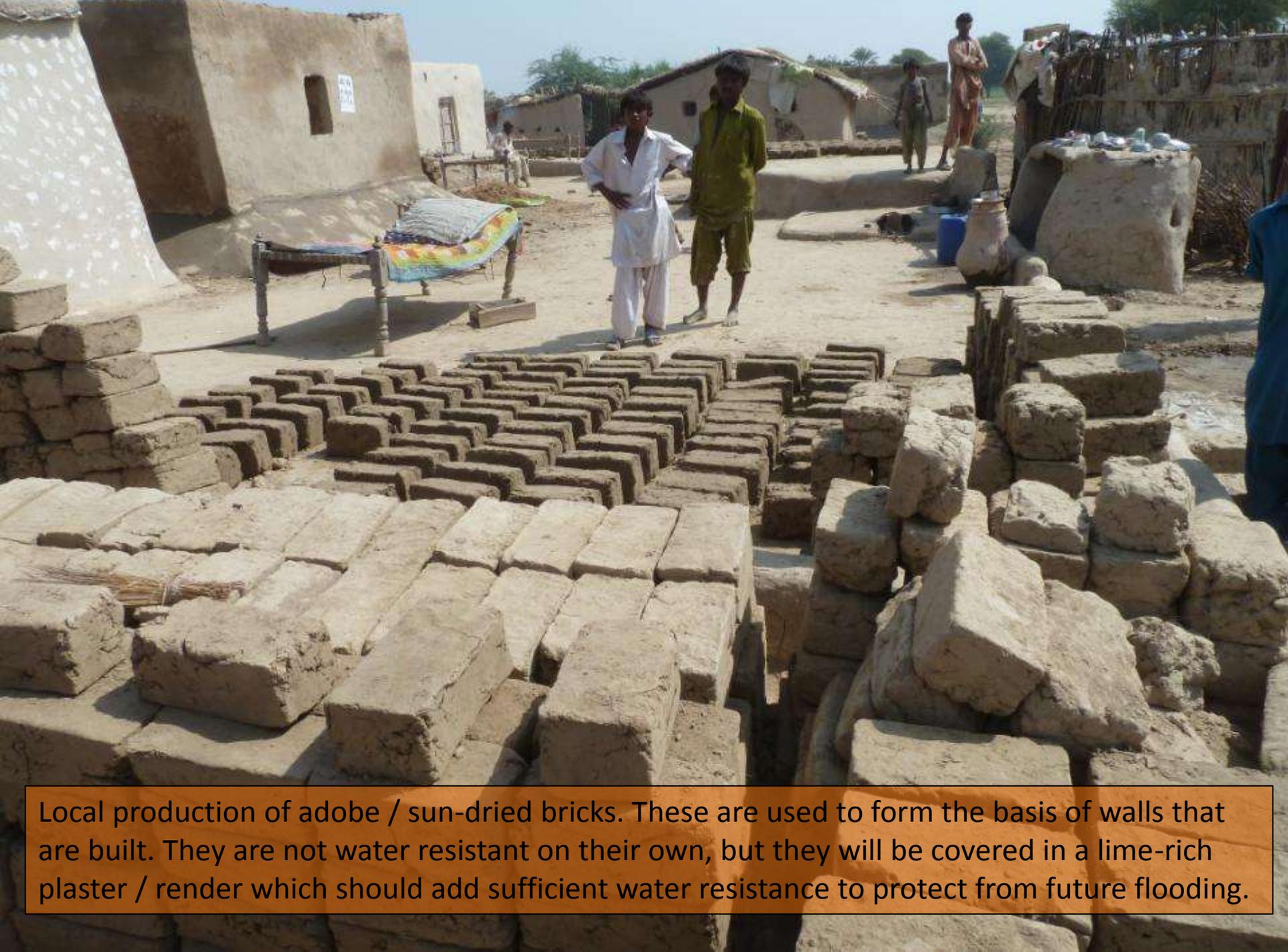
A properly built ring-beam could arguably distribute the weight of either steel or bamboo. So key questions are around supply, environmental impact and durability.



DFID's shelter advisor, Magnus, receiving a genuine and warm welcome in local villages.



HANDS teams testing the strength of lime-stabilised earth blocks made locally, which were then used to build the walls.

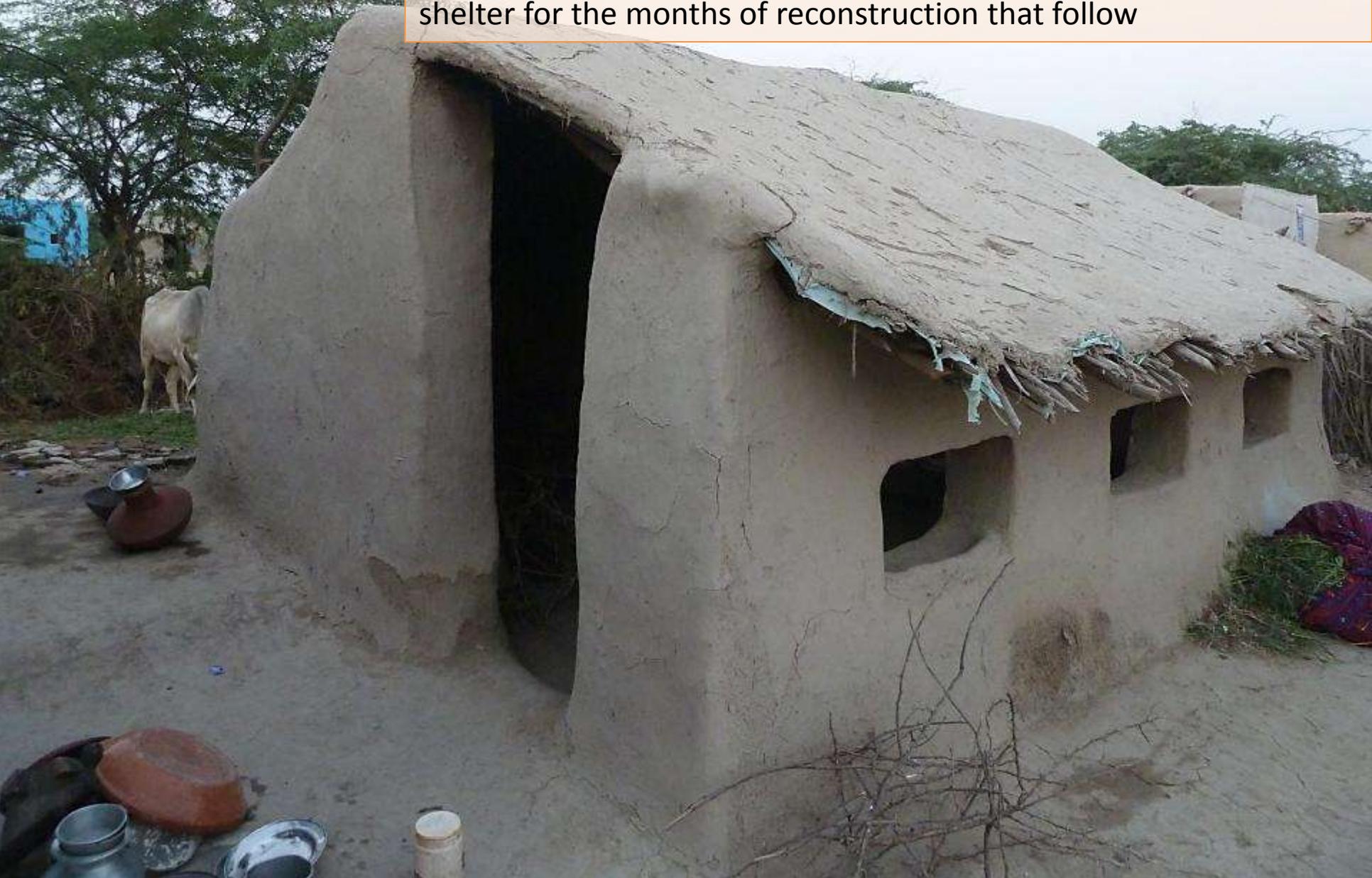


Local production of adobe / sun-dried bricks. These are used to form the basis of walls that are built. They are not water resistant on their own, but they will be covered in a lime-rich plaster / render which should add sufficient water resistance to protect from future flooding.

These same bricks are then used to build the walls, and are then plastered with a lime & earth mixture



A local shelter in Umerkot district, rebuilt after the floods – it is not intended to survive the floods, being entirely made of mud. As such it is a transitional home: better than a tent and sufficient shelter for the months of reconstruction that follow





Self-reconstruction (without technical support, but with roofing materials only provided & a solar light, shown). Note lack of roof projection (eaves) to protect top of walls, making them vulnerable to intense rainfall. Walls made from mud and manure will also be vulnerable to extended immersion in water and could collapse.



Passive cooling: this lime-reinforced earthen structure rebuilt with the guidance of HANDS follows traditional design that uses the veranda shade to reduce solar exposure to the house, thus reducing heat gains throughout the day.





Interacting with communities in South Eastern Sindh. Here around 25% of people are of Hindi ethnicity – mostly living in harmony with their neighbours. Government sponsored flood relief cash vouchers were received by Hindi communities too, showing that ethnic discrimination is not evident – and it was not raised as a concern by people themselves during discussions.



A typical local house in SE Sindh. Especially vulnerable to floods because of exposed earthen walls, lack of lime or other impermeable render, poor detailing on roof at edges of the roof, use of very heavy wooden beam which will transfer weight to walls weakened by heavy rains, causing them to collapse.

**Heritage Foundation is DFID/IOM's local technical design and training partner. Here they have built a series of building components to help with training of local people and organisations, showing them how to build flood resistant buildings with natural materials.**





**Yasmeen Lari, head of Heritage Foundation explaining the different components**

An example of bamboo structure for a twin-pitch roof. This avoids the use of local **trees** – a non-renewable source of building material, causing serious environmental damage

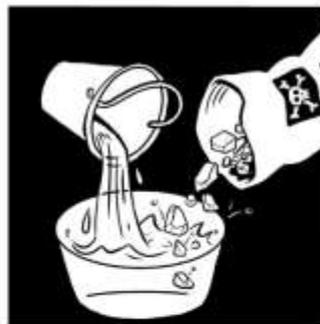


A cross-section of a safe foundation made from earth and lime, with a projected “toe” to give further durability in case of flooding

# A quick introduction to Lime

- An ancient building material that could be the key to flood resistant housing in Pakistan





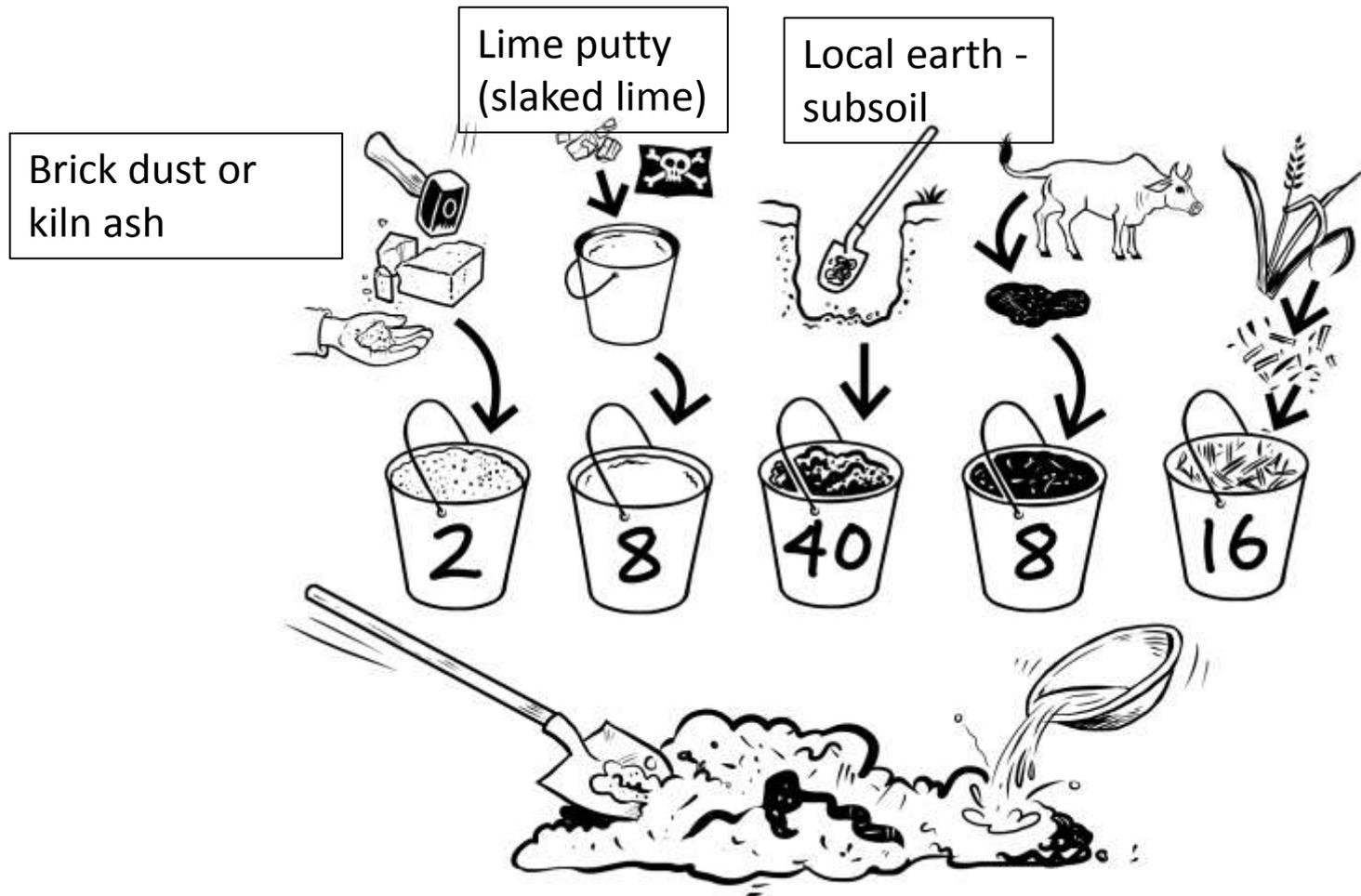
**First:  
Health and Safety!!**



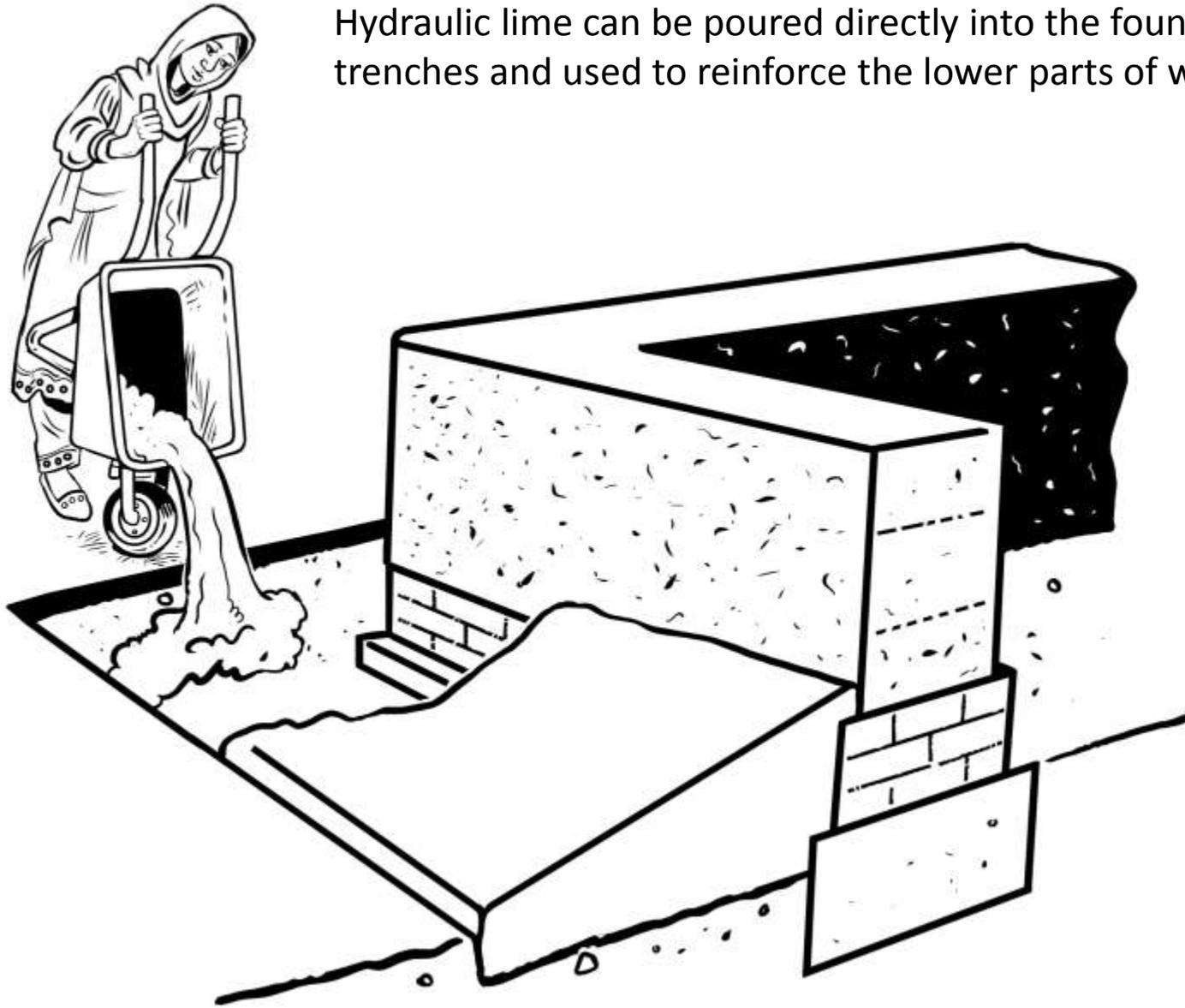
# Hydraulic Lime

- Hydraulic lime is a variety of lime that sets in contact with water. It can sit underwater for hundreds of years and not deteriorate
- It was often used to build pillars in rivers for bridges. The Sukkur barrage used this system.
- Used for flood resistant shelters it could replace bricks and cement mortar for foundations and lower sections of walls.

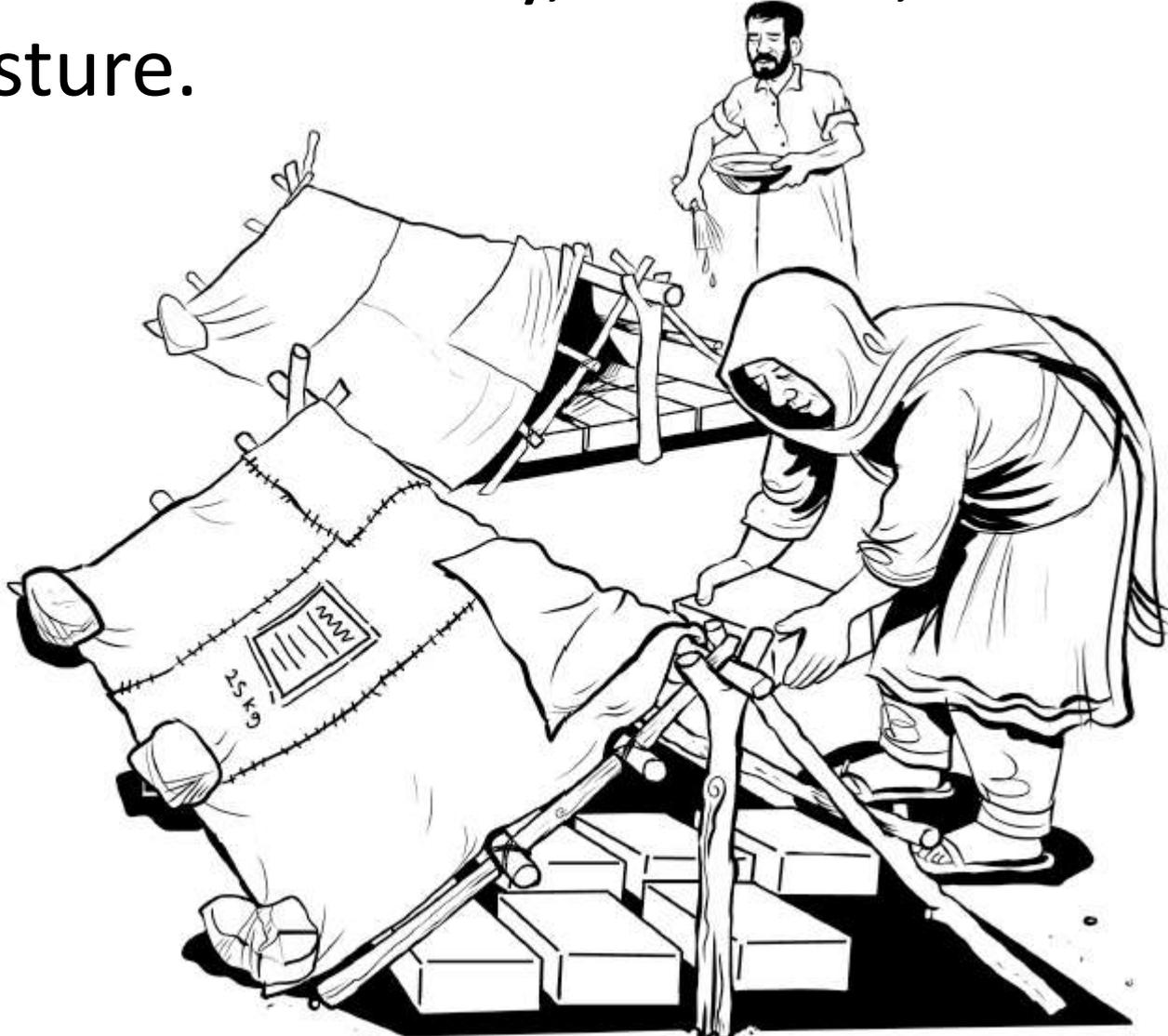
This shows an example of a good hydraulic lime mortar, that could be used for flood resistant shelters. Animal manure helps with plasticity for renders / plaster, and cut straw acts as a fibre to prevent cracking but neither are strictly necessary for foundations.

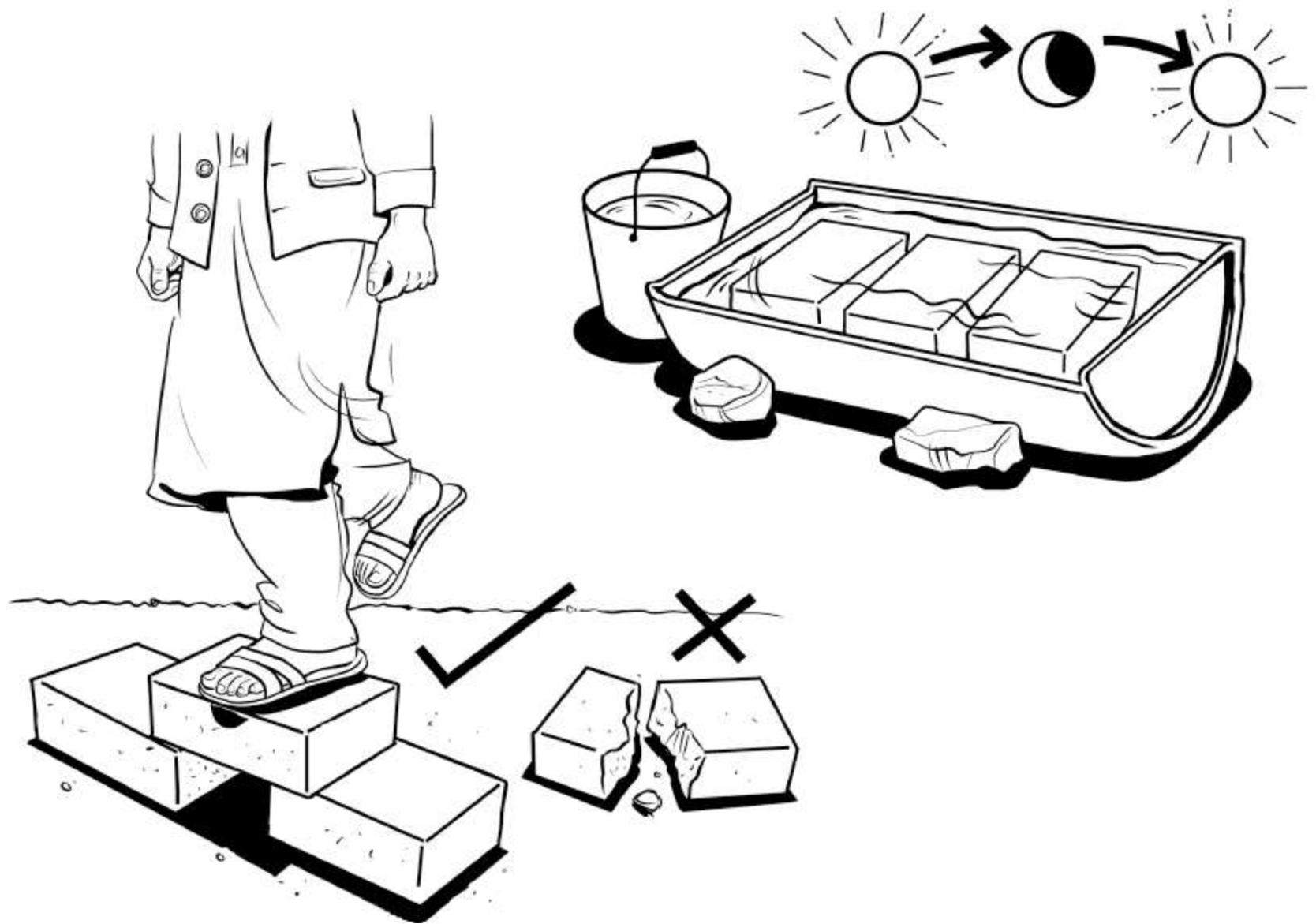


Hydraulic lime can be poured directly into the foundation trenches and used to reinforce the lower parts of walls, as shown.

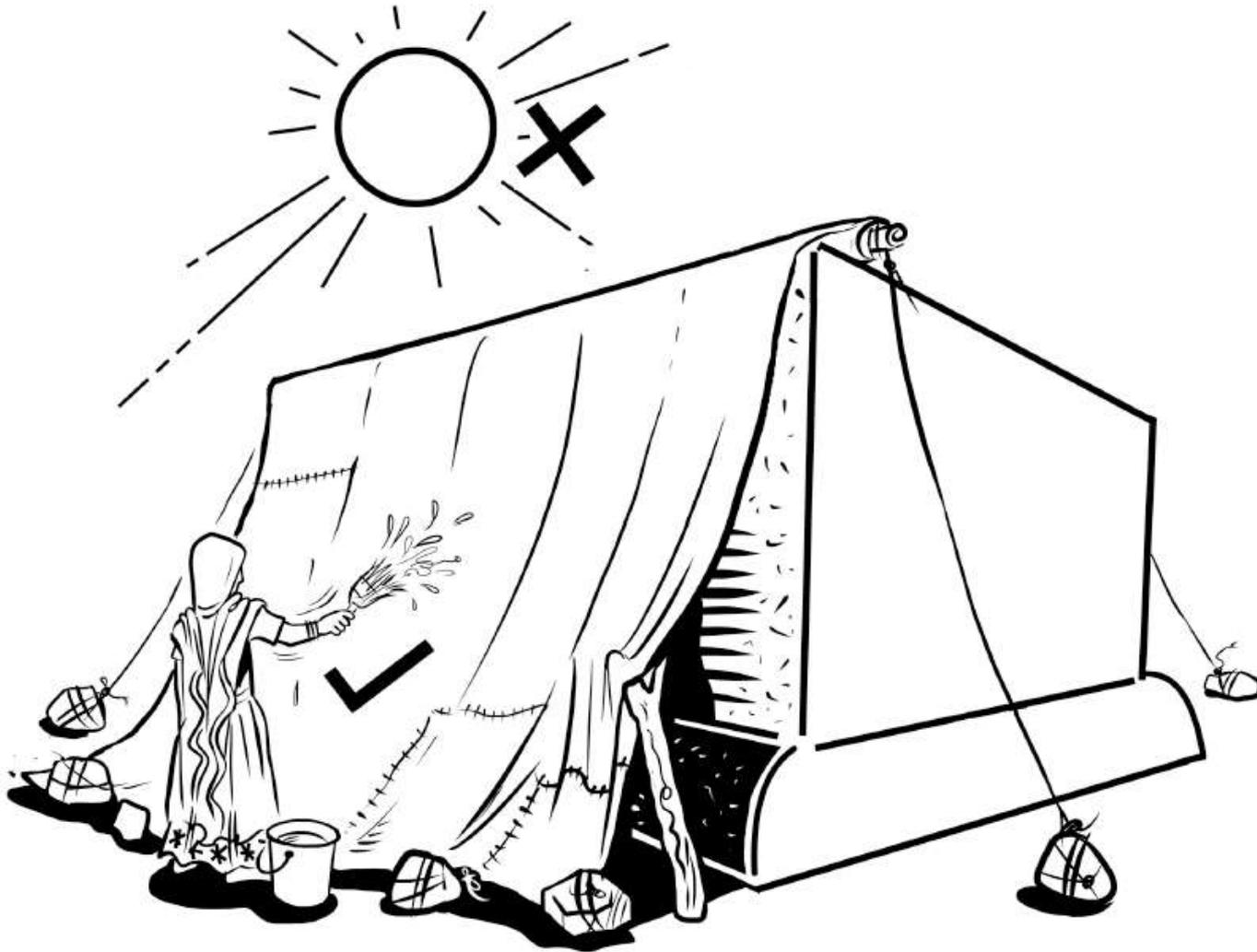


Bricks made with hydraulic or normal lime need to cure slowly, in shade, with moisture.





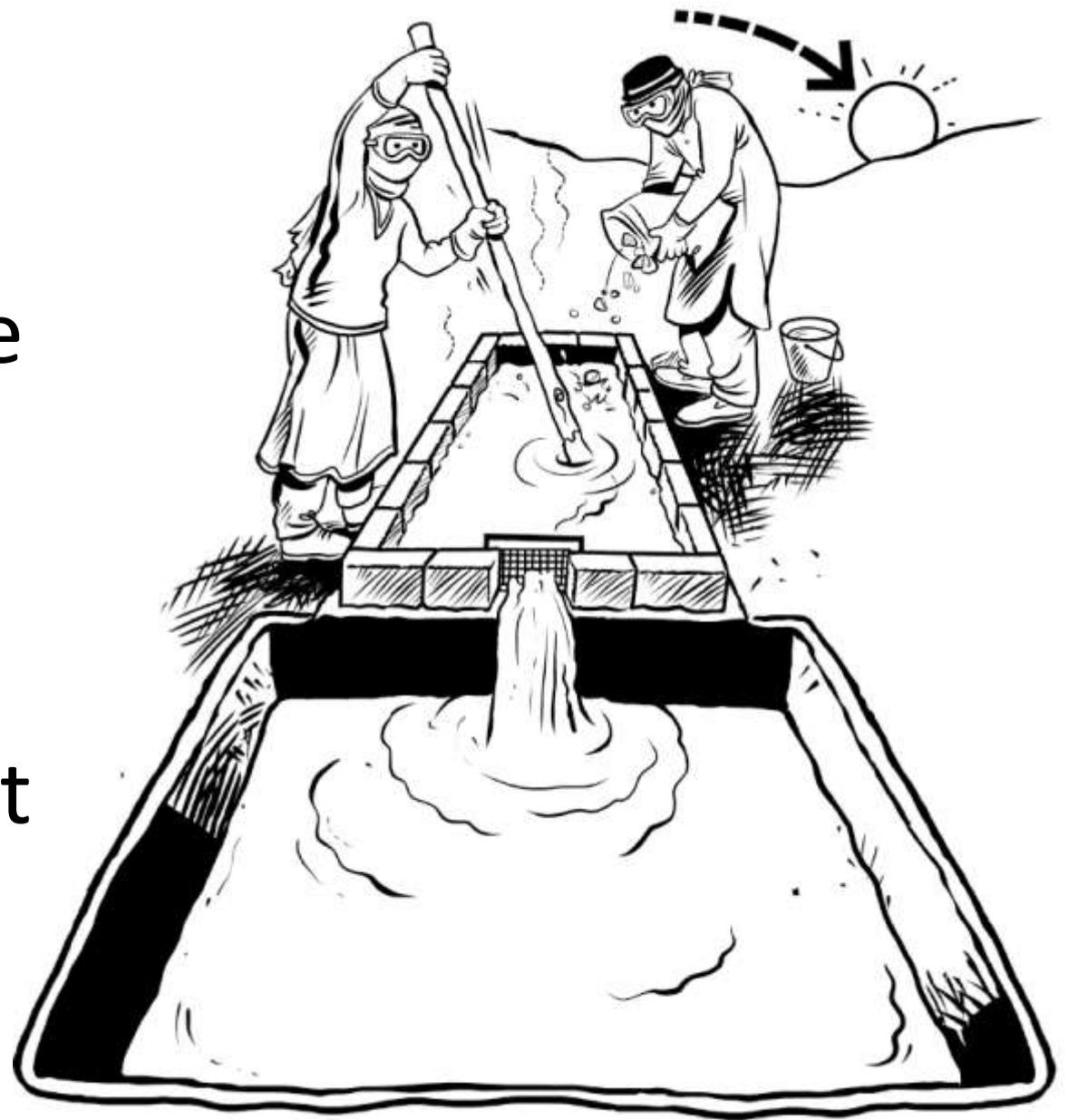
Walls rendered / plastered with lime-rich mortar should be kept under shade to prevent them from drying out too fast. Unlike cement, lime dries by carbonating (absorbing  $\text{CO}_2$  from the atmosphere) eventually returning to its original form of limestone. But carbonation needs time and exposure to sunlight will disrupt the process.

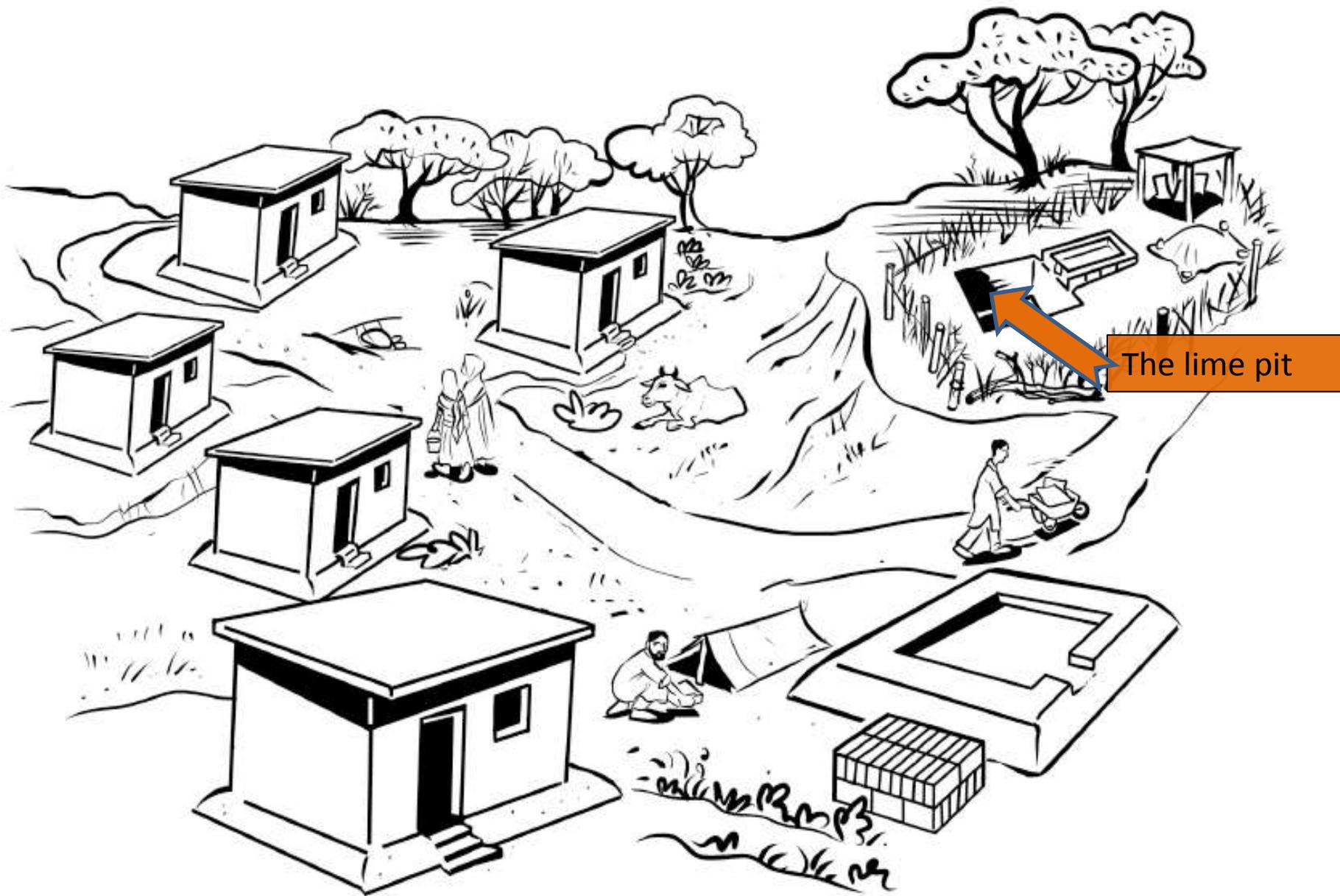


Slaking lime

To make “lime  
putty”

The KEY to  
flood resistant  
walls





Artist's impression of village in recovery – with one lime pit per community, managed by a “lime focal person”, who could ensure quality of lime products for wall render, bricks, hydraulic lime base, etc.

# Acknowledgments

- Yasmeen Lari, founder of the Heritage Foundation for technical consultancy, designs and training IOM local implementing partners
- Manuel Pereira, project manager of the IOM programme – 27,500 houses over 6 districts working through 18 local partners
- Mustafa Ghulam, project manager HANDS, managing 28,000 houses over 6 districts directly with village based CBOs
- Saad Khan, lead trainer, Heritage Foundation
- Bee Rowan, leading UK lime consultant, programme advisor (lime technology)
- Juliet Breese, illustrator (for lime drawings displayed)