ENERGY
AND
SELF-RELIANCE

Yona Friedman

Communication Center of Scientific
Knowledge for Self-Reliance
33 BD Garibaldi, 75015 Paris, France

Energy and Self-Reliance

A unique book on Energy. Over 300 drawings, each accompanied with a simple text. Today in most progressive schools 'Environment & Energy Education' has become a must. Recent school campaigns in curbing the use of plastic bags, and crackers have borne heartening results.

This simple picture manual could be very effectively used by school children for undertaking projects and tackling real Energy and Environmental issues. Issues like Environment and Energy are too precious, to be left to the mercy of experts. We all have a stake in the environment, specially the children.

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Introduction

Communication for Self-Reliance

Today we find ourselves in a multifaceted, global crisis that touches every aspect of our lives: our health and livelihood, the quality of our environment and our social relationships, our economy, technology, our politics - our very survival on this planet. The nations of the world have stockpiled more than 50,000 nuclear warheads, enough to destroy the world several times over, and the arms race continues at an undiminished pace. While worldwide military spending is more than one billion dollars a day, more than fifteen million people die of starvation annually - thirty two every minute, most of them children. Developing countries spend more than three times on armaments as on healthcare. Thirty-five percent of humanity lacks safe drinking water, while nearly half of its scientists and engineers are engaged in the technology of making weapons. Economists are obsessed with building economies based on unlimited growth, while our finite resources are rapidly dwindling, industrial corporations dump toxic wastes somewhere else, rather than neutralizing them, without caring that there is no 'sink' on mother earth. Modern medicine often endangers our health. The scourge of HIV/AIDS is threatening to wipe out entire nations in Africa and Asia.

While the world's ten percent rich, corner and control over eighty percent of the world's resources, the poor are left to fend for themselves in shanties and ghettos. Diseased and ill fed, the poor in the Third World — deprived of any 'social security net' have been pushed to the very brink of survival. Amidst mounting food stocks, the poor still starve to death, as governments often have no mechanism to even dispense 'charity'.

It is in the context of this grim social scenario that the work of Yona Friedman —a French architect and humanist of international repute, becomes so relevant. Friedman was born in Budapest, Hungary in 1923. He studied at the Technical University in Budapest, before continuing his training at the Technion in Haifa, Israel. In 1957, Friedman set up a studio in Paris and continued his work from there. His belief that an architect, rather than having an autonomous point of view, should instead be there to serve the users and offer advice on technical and organizational matters, gained him few allies among the professional fraternity of architects.

In the early 1960s, he made animation films for French television based on African folk stories; he developed a computer programme with which the user could design his own apartment; and he advanced the sociological definition known as the critical group-size, which dealt with the communication among groups of people.

Friedman also devised his own special visual language to communicate 'life skills' and 'survival skills' for self-reliance to ordinary unlettered people. 'A picture is worth more than a thousand words' — that people always think in images and pictures and not in words, is the bedrock of his strategy. To communicate scientific knowledge to the poor, Friedman uses a 'sign' language — a small hieroglyphic matchstick figure, accompanied by a few words. His non-threatening, exquisite artistry, coupled with his humanism has blazed an entirely new path in the realm of science communication. His message, simple and direct goes straight to the heart.

Along with his able assistant Ms. Eda Shaur, Yona Friedman has been able to create over 300 picture manuals on a very diverse range of survival skills for the benefit of humanity at large. The

topics range from environmental education, architectural self-planning, minimal kitchen gardens, growing food on shelves, fighting the drought, disaster prevention, health and nutrition, safe drinking water, basic sanitation, water harvesting etc.

These cartoon strips have been serialized in hundreds of newspapers and magazines across the world. Full credit goes to Mr. B. Khan — ex-editor of the science magazine ***Invention Intelligence*** for making a host of these picture manuals available to the Indian public for the first time. It is with the kind permission of Mr. B. Khan that the present volume is being printed. Like most visionaries, Yona Friedman's work is in the public domain, and it is hoped that the publication of this volume will inspire its translation into various Indian languages. These books have already been published in Hindi, Marathi, Oriya; and the Tamil Nadu Pollution Control Board has recently commissioned the Tamil translation. It is hoped that these books will give fillip to the printing of Yona Friedman's other picture manuals.

Friedman was also commissioned by UNESCO to make various studies of housing issues in Third World countries. A few years back, Friedman won the coveted ***Japan Award*** for designing a low-cost roof for the Third World. Under the auspices of UNESCO, he built the Museum for Simple Technologies in Madras (India) in the early 1980s.

Friedman never actively allied himself to prominent groups or movements within the world of architecture or urban planning, but through his teaching activities and publications (over 500 articles and several books), his ideas have become widely diffused.

Today 'environment education' is the buzzword in progressive schools. Recent school campaigns in curbing the use of plastic bags, and crackers during the festival of *Diwali* have borne heartening results. Friedman's simple manuals could be very effectively used by school children for undertaking projects and tackling real environmental issues. For issues like Environment and Energy are too precious to be left to the mercy of experts. We all have a stake in the environment, specially the children.

As Chief Seattle — the wise and widely respected Red Indian Chief said in his most eloquent statement 150 years ago:

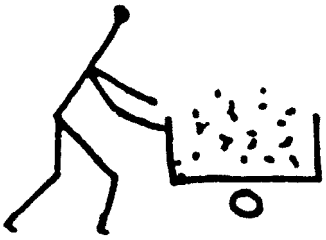
This we all know:
All things are connected like the blood that unites us,
We did not weave the web of life,
We are merely a strand in it,
Whatever we do to the web, we do to ourselves.

- Arvind Gupta

What is energy?

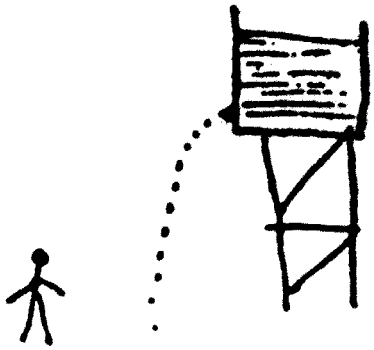
Energy is available in nature in different forms.
It is acquired by living beings
in different ways to be made use of
in their various activities.

Energy can be manifest, for example as work or heat



It might be in a latent or potential form manifesting itself only when triggered

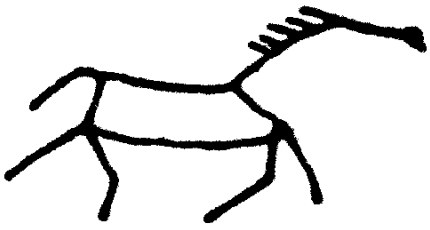
for example, when petrol is lighted



or when accumulated water is released. Most energy sources have energy in latent form.

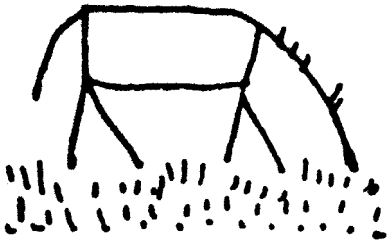
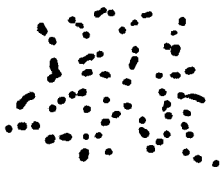
The word “Energy” basically means “Work”.

Work is defined by scientists as moving a mass along a distance

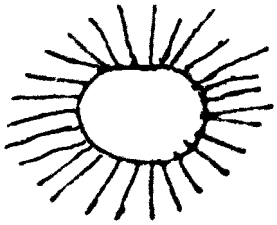


A horse that weighs 200 kilograms and which walks one kilometer performs work equivalent to 200 kg x 1 km

If the horse carries a basket of 100 kgs it performs 300 kg-km of work, only 1/3 of which is useful.

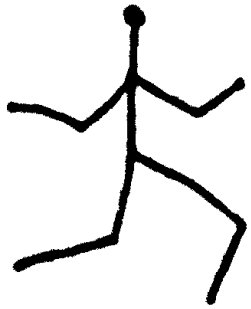
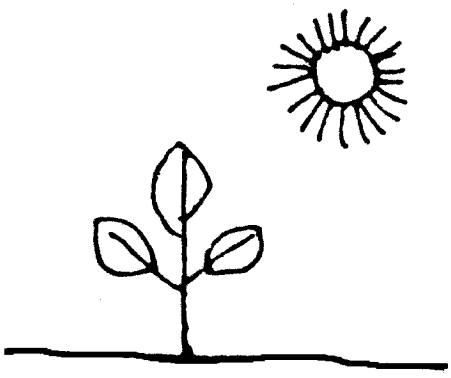
	For doing that work the horse consumes energy by way of food.
	Heat is also a form of work : the masses that move in this case are the molecules of the hot matter
	The molecules move to distances invisibly small. But even in a very small object there are billions of molecules.

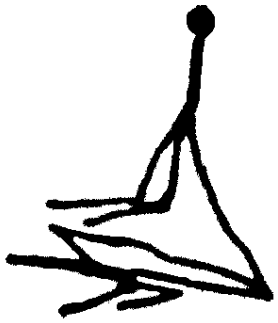
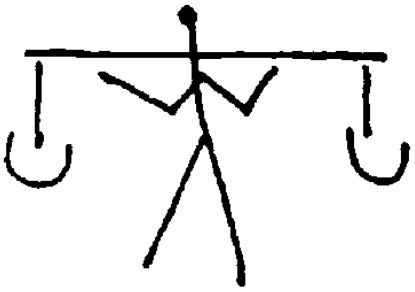
	Therefore, the heat that results might be considerable

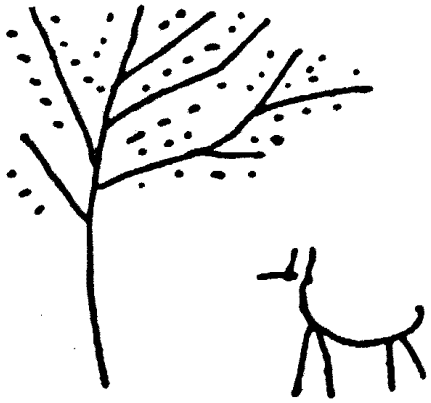
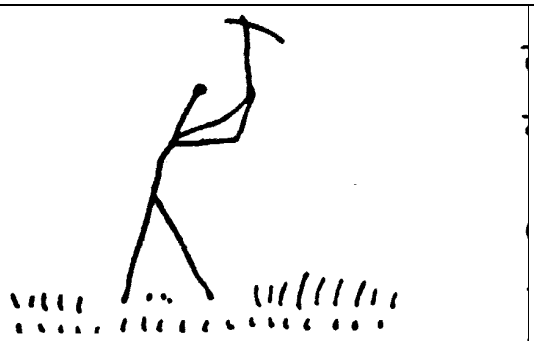
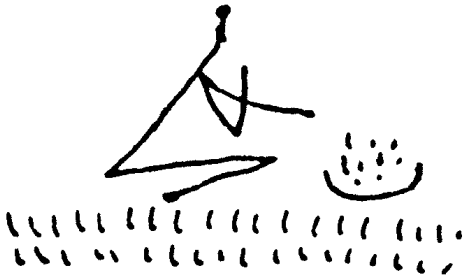
	Heat is thus another form of energy the primary source of which is the Sun.

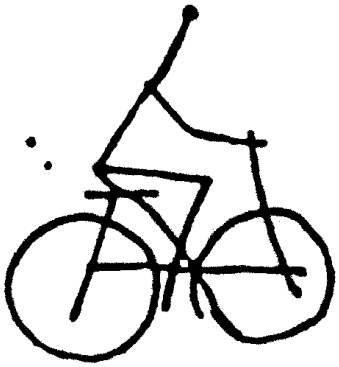
How energy is used?

We use energy in various ways:
while doing work,
cooking, lighting,
running machines etc.

	Everybody consumes energy. Your body does it when you move to work.
	You produce that energy from the food you eat and the air you breathe.
	All living beings consume energy. Even the plants for their growth take energy out of sunlight.

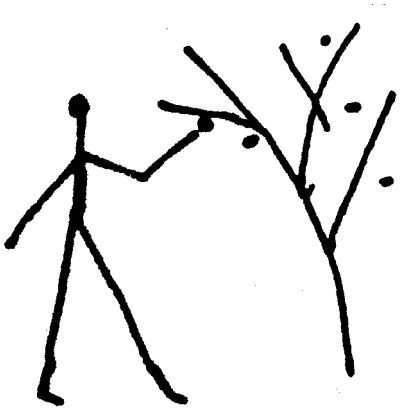
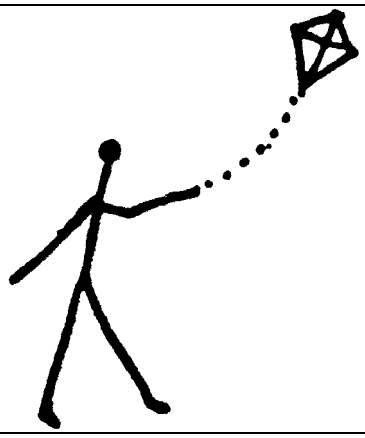
	You also consume energy when breathing. You exhale used air and take in fresh air.
	When eating you take in new fuel.
	When doing anything you spend the energy accumulated by breathing and eating.
	Even when you are asleep you spend energy.

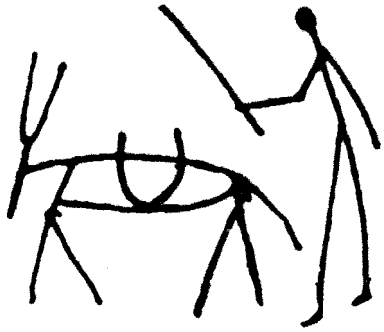
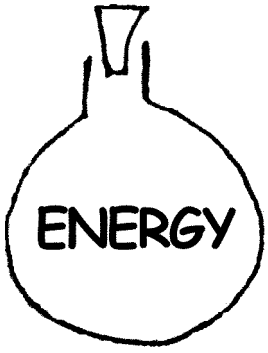
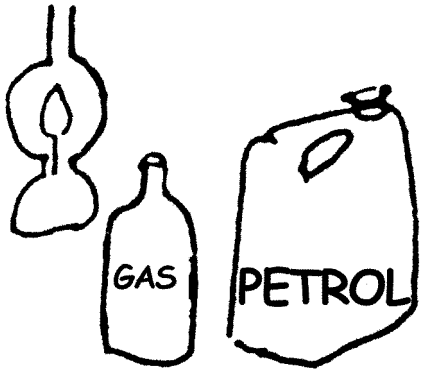
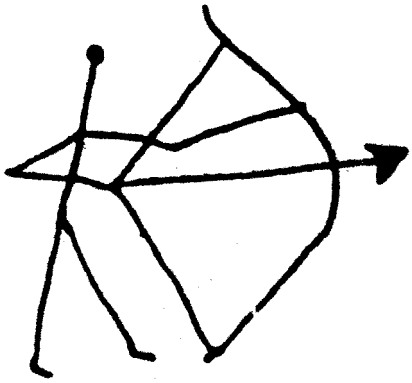
	Any life be that of animals, plants or humans
	consists of consuming energy and spending the reserves of energy so stored.
	And it consists also of replenishing the energy reserves with fresh energy. It is a continuous cycle of life.
	The artifacts made possible by people need energy for their operation.

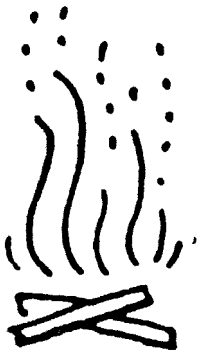
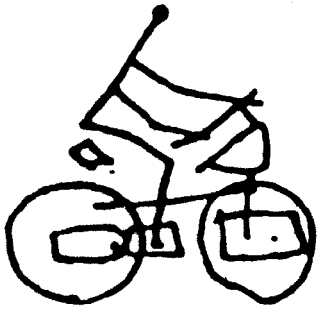
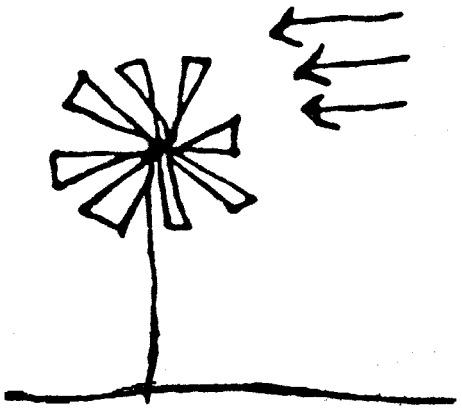
	The fire on which you cook your food
	or the lamp you use for light at night
	or the machines that move and work – all of them consume energy

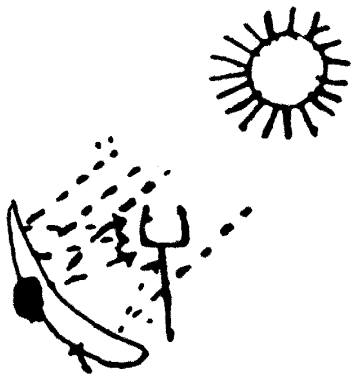
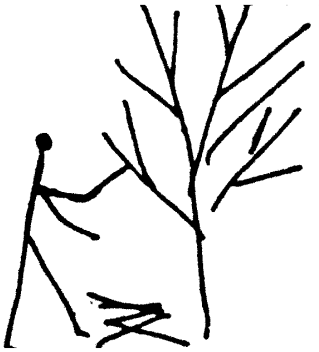
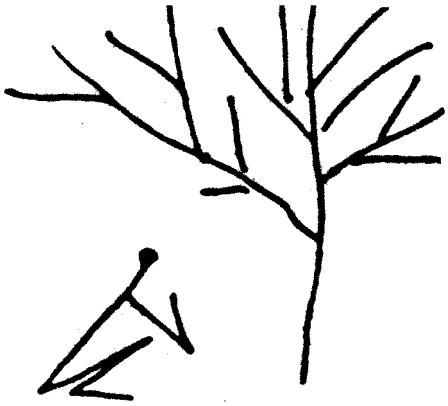
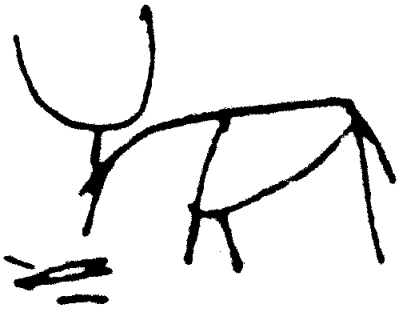
Sources of energy

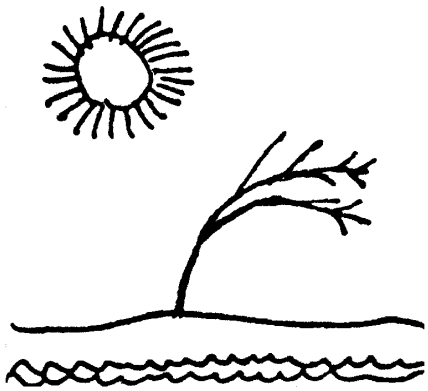
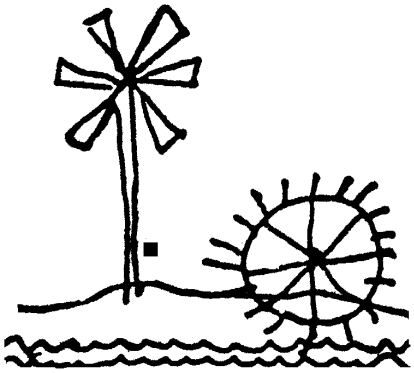
There are many sources of energy in nature –
non-renewable, renewable
and those abundantly available.
What is required is knowledge
to use them optimally.

	To be able to consume energy
	you have to take that energy from some kind of energy source.
	The source may be a manifestation of energy that occurs in nature, like the wind

	or it may be your own body or the body of an animal. In all these cases you have to use a converter of some kind.
	Energy sources are often a sort of "reserve"
	like petrol, gas or even firewood : these are inert substances, which liberate energy when burnt.
	Energy sources can be mechanical reserves too like a spring stressed

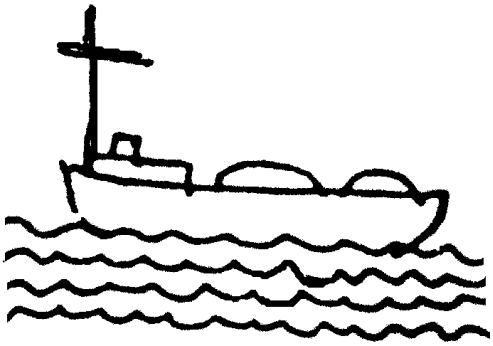
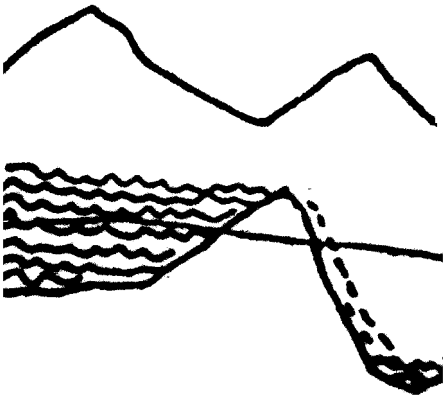
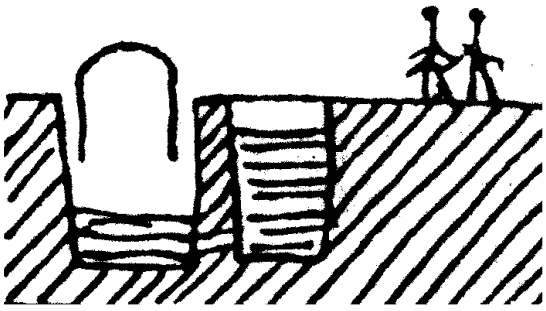
	or a weight ready to fall down. But, to get energy from such mechanical sources you must put energy into them.
	Fuels are materials, which liberate energy when burnt – for example, wood and charcoal
	or even petrol used up in a motorcycle. But these might be expensive.
	Energy manifestations occurring in nature don't cost money , for example, wind, running water

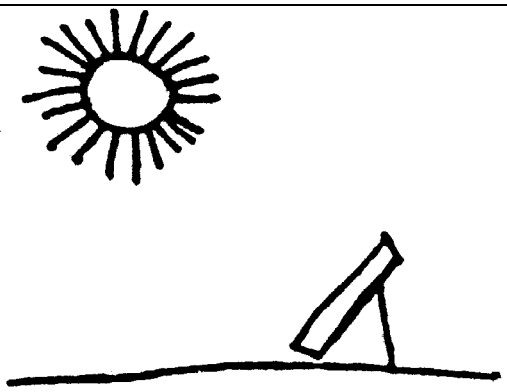
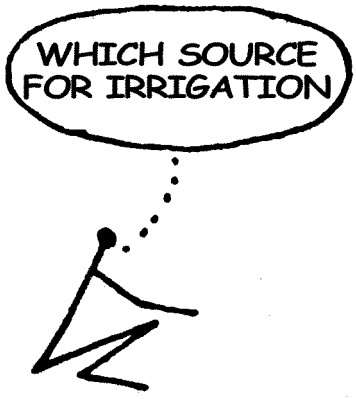
	or sunlight is freely available. But the converter required might be sometimes complicated.
	Some energy sources are renewable like firewood from trees, which grow from the soil
	and can re-grow their shoots again if you know how to take care of them.
	So is animal energy, because animals can restore the strength after eating and resting

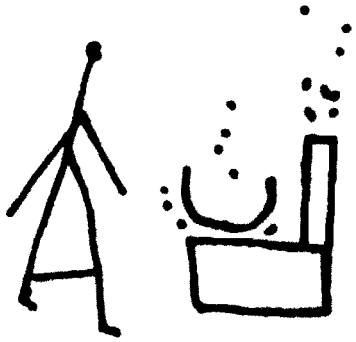
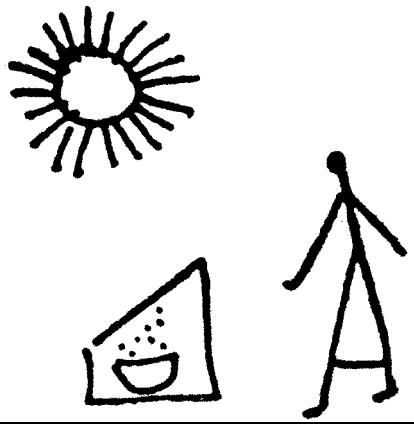
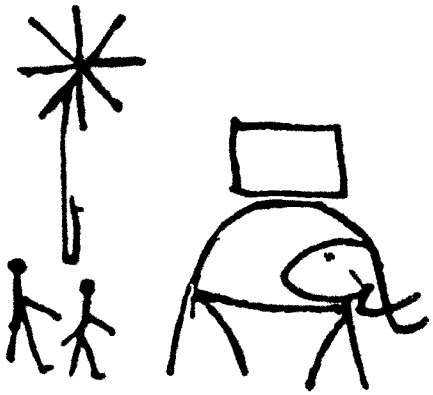
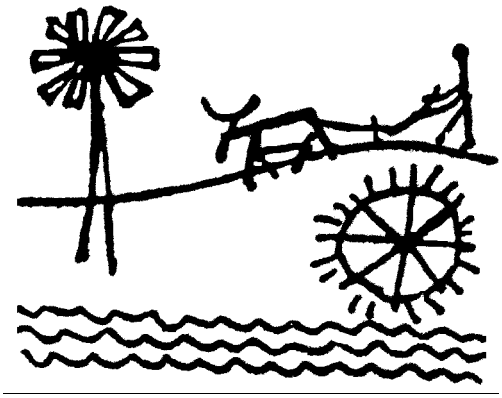
	Some sources of energy are always present in nature like wind, sunshine or running water
	whether you exploit them or not.
	Most energy sources (even renewable ones or those always present) are obtainable only in limited quantities: you have to use them economically
	so that they do not become scarce later when you have used up all the reserves available in your locality.

Energy sources you can find around you

Firewood, wind, flowing water,
sunshine, etc.
are a few of the energy sources
you can find around you.

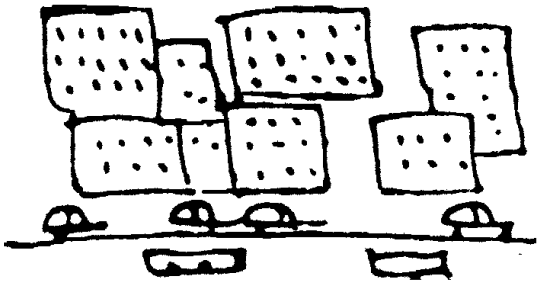
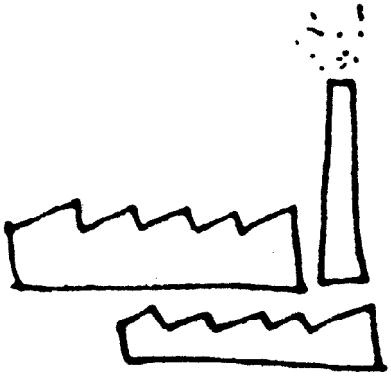
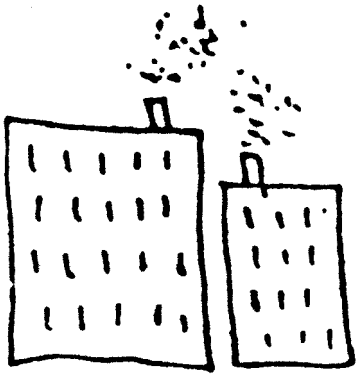
	You have to take energy from energy sources available either imported or locally available.
	There are many kinds of energy sources in the rural areas which being locally available are inexpensive
	Such inexpensive energy sources are, for example, biogas,

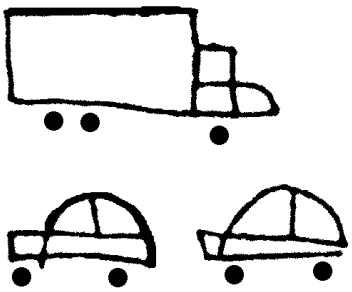
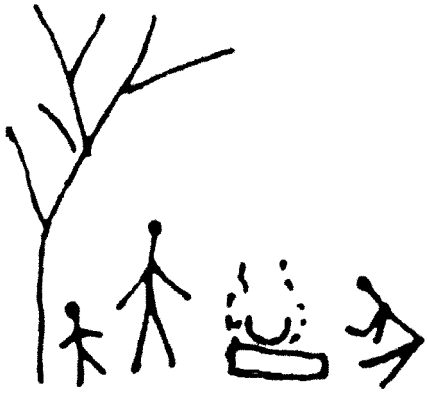
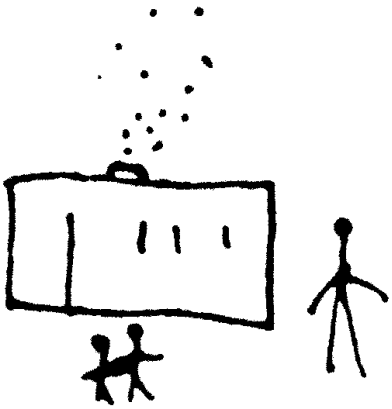
	firewood,
	wind power, running water, animal labor,
	sunshine and many others.
	Some of these energy sources are more suitable for particular kinds of use.

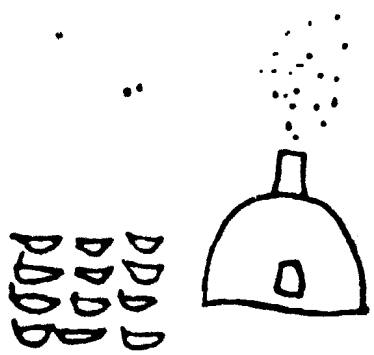
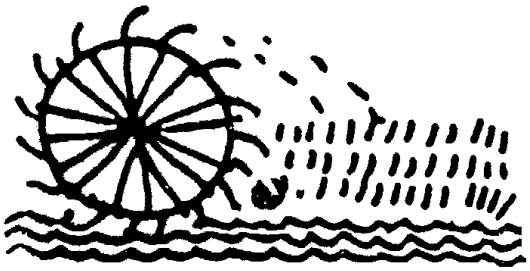
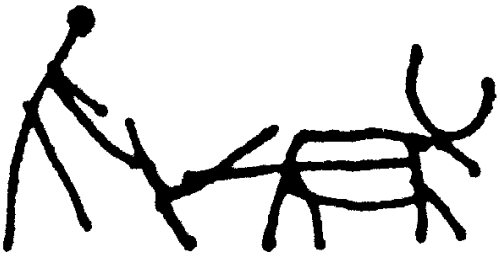
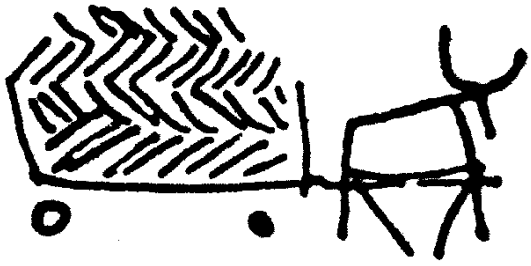
	For example, biogas or firewood are convenient for cooking or heating
	and so can be solar energy.
	Wind and running water are adaptable for continuous use in the same place whereas animal labor need not be used at a fixed spot.
	You can yourself exploit many energy sources available around you, but other sources like firewood or biogas you can sell like any other farm product.

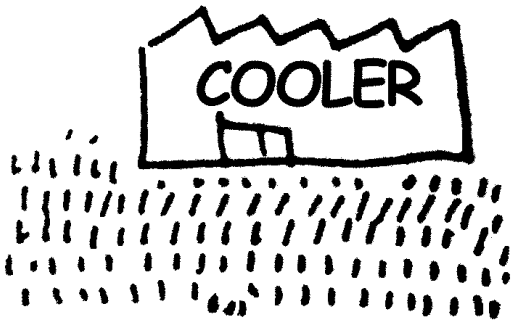
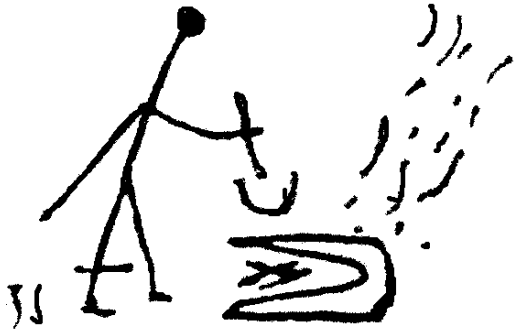
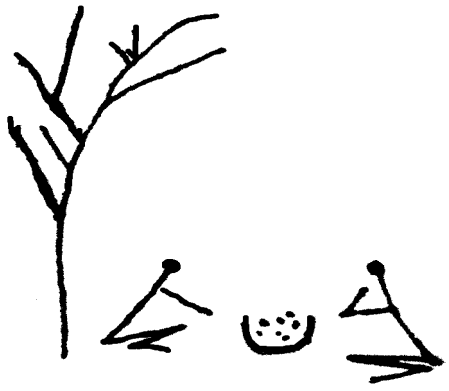
How energy is consumed by man

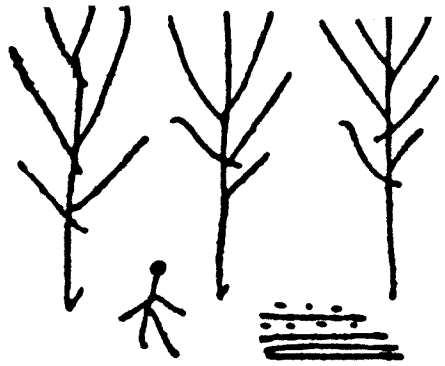
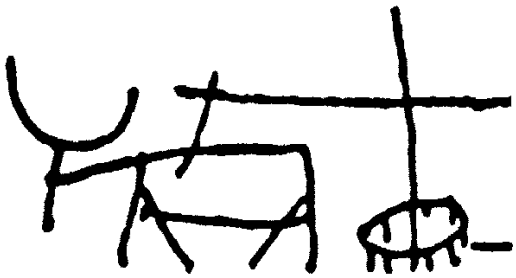
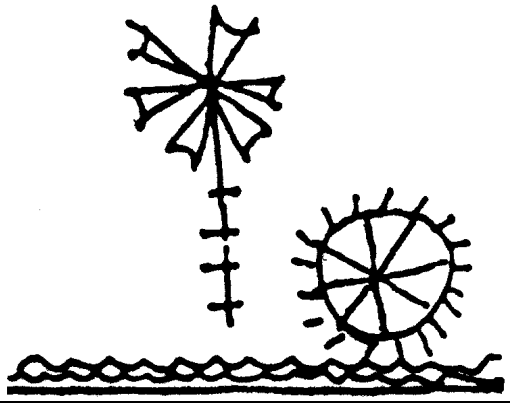
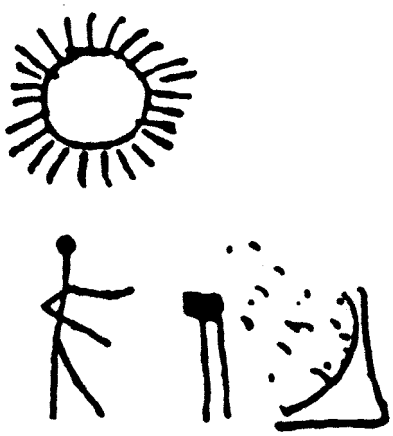
To use energy profitably
we need appropriate
converters to suit particular needs,
some of which we can make ourselves
at little cost.

	Cities consume more energy than villages:
	in plants and factories for running machines or for other purposes;
	in homes, hotels and hospitals for cooking, heating, cooling and lighting;

	on roads and railways for transporting goods and people. In fact, energy is used for all community services.
	Villages use less energy for limited applications:
	for cooking food;
	for lighting and heating houses;

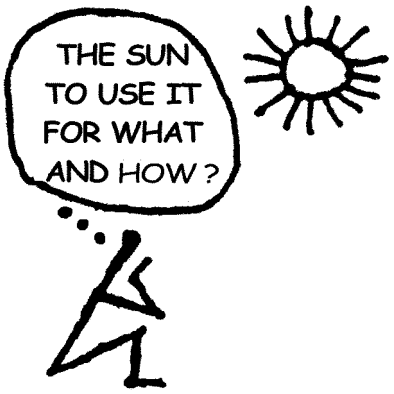
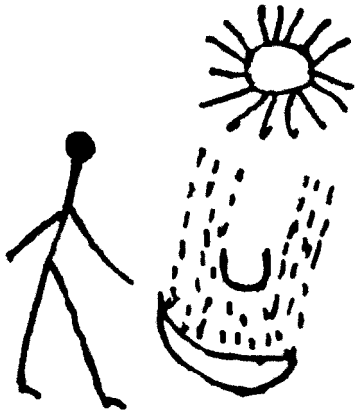
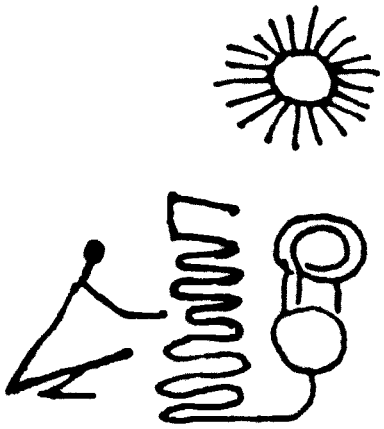
	and for cottage industries, pottery, brick making, weaving, black smithy etc.
	Farming, too, consumes energy: for watering the fields;
	for ploughing and harvesting;
	for transporting the crop.

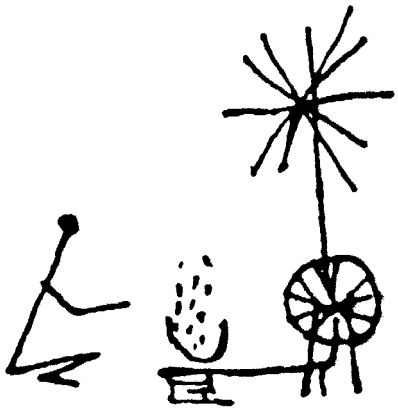
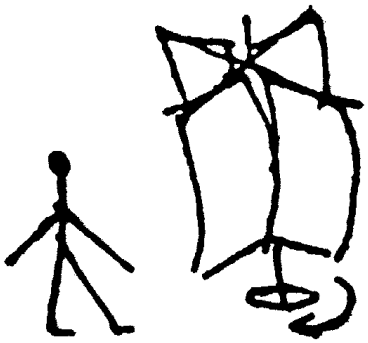
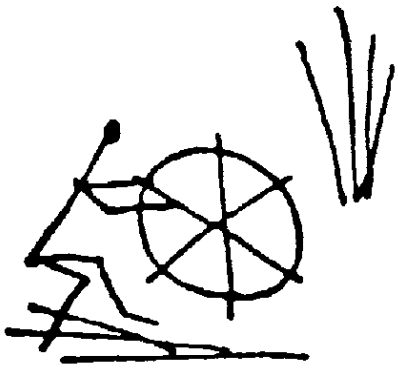
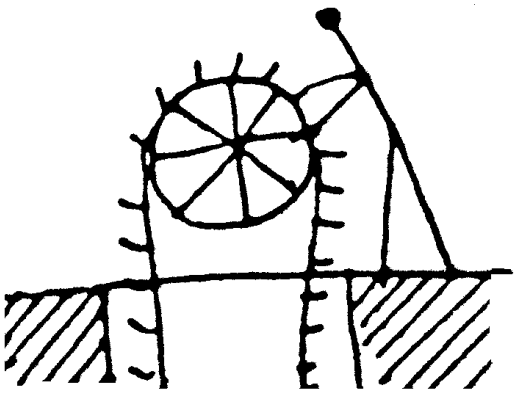
	for storing the perishables.
	It is possible for villages and rural settlements to produce all the energy they need.
	And to make themselves the necessary energy converters
	that would furnish all the energy the people could need.

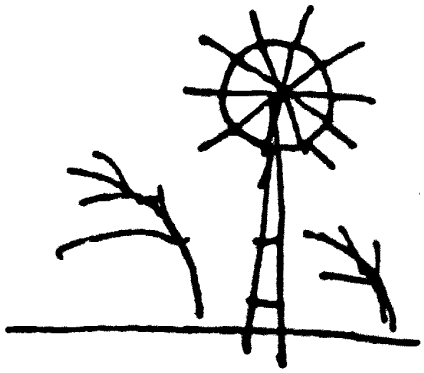
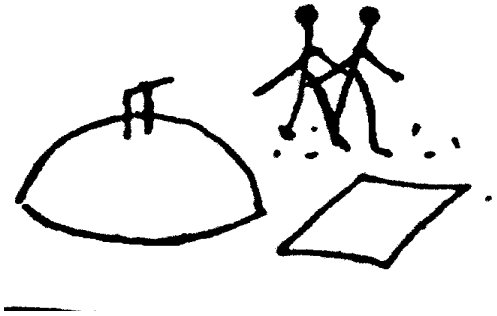
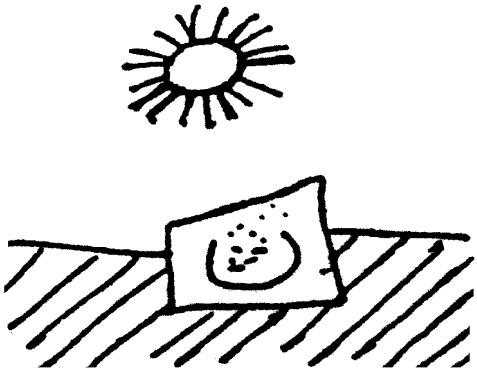
	Such energy sources are firewood
	and animal and human body energy;
	and such converters are windmills and waterwheels,
	solar devices, gravity storage systems and other similar equipment.

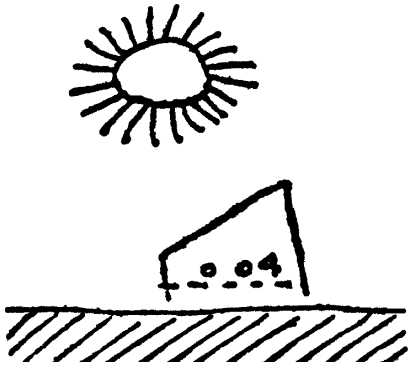
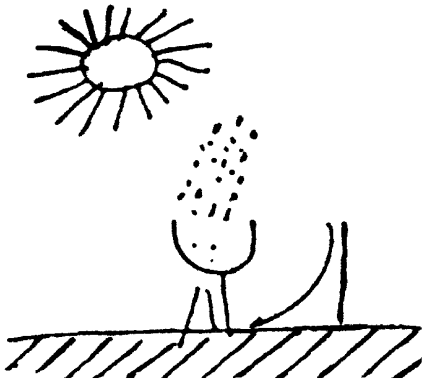
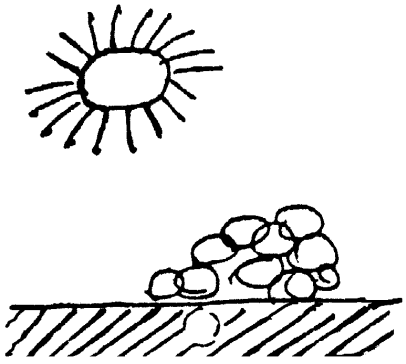
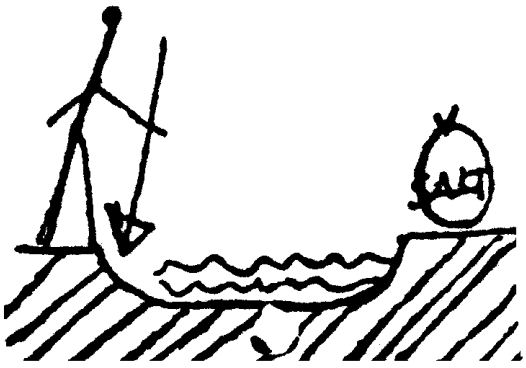
Machines that make energy useful

By using simple machines
we can transform energy
and use it for
our daily needs.

	To make use of the right energy source for the right purpose
	you should know how to make the right converters. An energy converter might be simple,
	or complicated

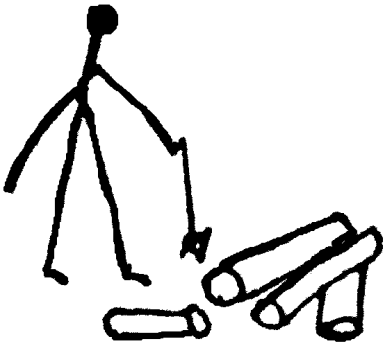
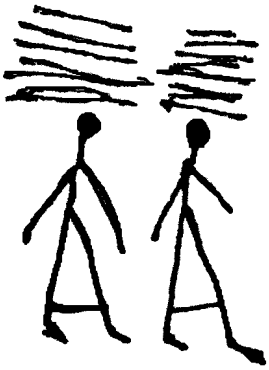
	and it might turn the energy into heat or into movement.
	Many of these converters can be made with a little money or labor.
	Many of these converters can be made with a little money or labor.
	You can make simple water lifts,

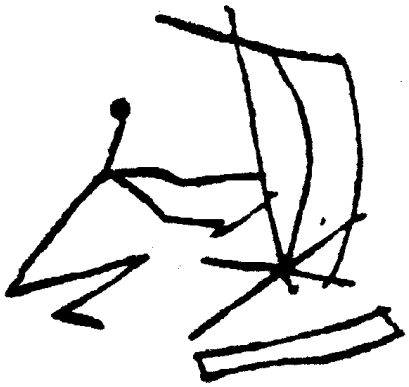
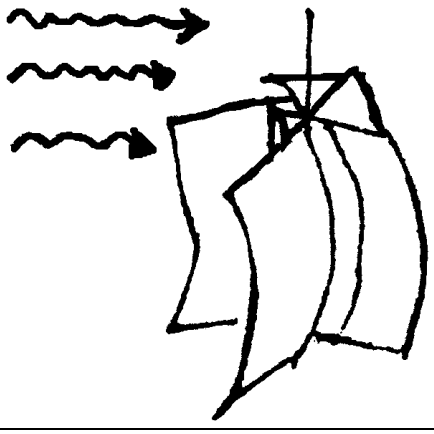
	windmills and waterwheels,
	simple stoves (which reduce fuel consumption)
	and even biogas plants with little effort and little costs.
	And you can use the sunshine for cooking your food,

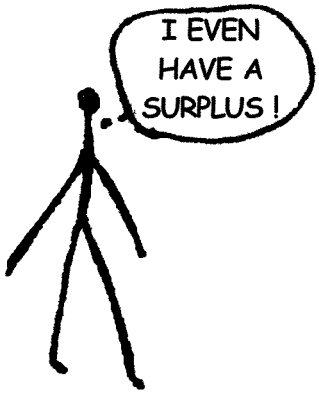
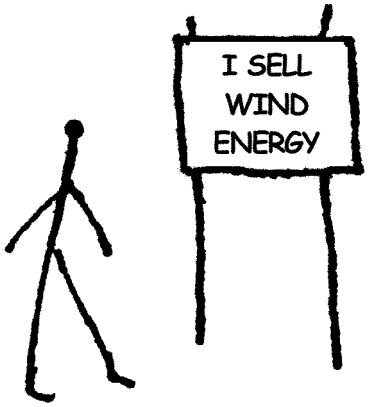
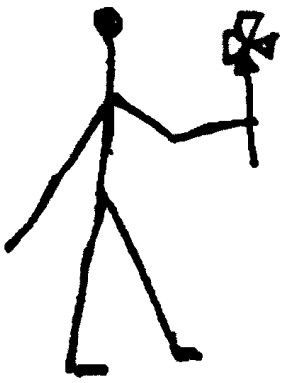
	for drying food grains and vegetables to be preserved,
	and for heating anything that needs to be heated.
	There are ways to conserve the heat of the sunshine overnight, to be used till the sun rises again.
	Simple converters and storage systems can do this for you

Managing our energy sources

Our energy sources should be managed in terms of production, consumption, marketing and renewing, to ensure that our future energy needs are not affected.

	Just as it is important to save money by proper budgeting
	it is essential to save energy sources by healthy energy management.
	For example, if you use more firewood (or biogas) than the amount you can produce yourself

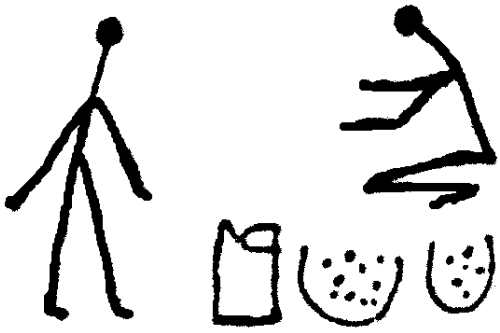
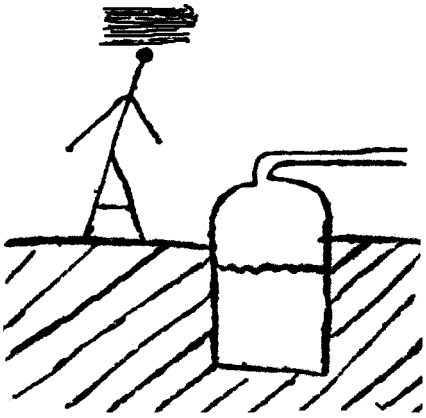
	then sooner, or later, you will run out of it.
	Making a converter with your own means
	and using energy sources that you can produce yourself (for example, firewood)
	or which are always readily available (for example, wind or sunlight)

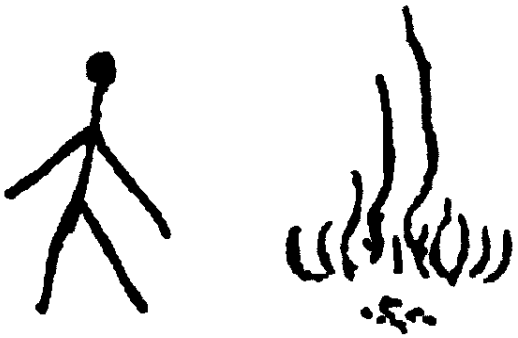
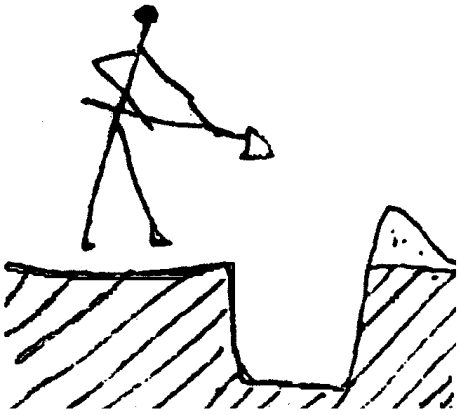
	can assure you sufficient energy for all your needs, for all times
	If, by any chance, you produce more energy than you directly need
	you can sell the surplus energy,
	or the other converters that you have built to others who need them.

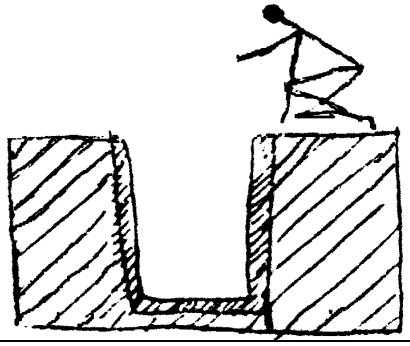
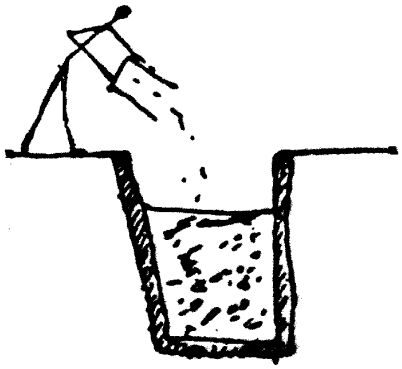
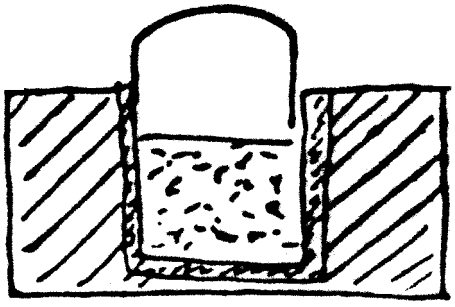
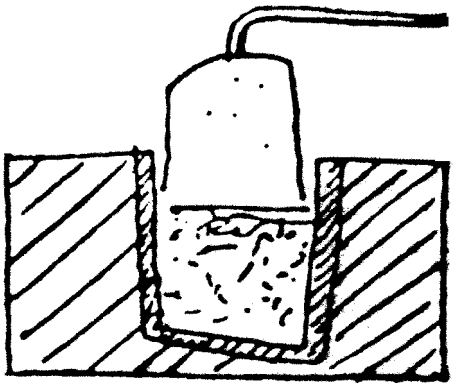
	But while selling energy you must keep enough reserve to meet your future needs.
	For example, if you sell surplus wood, don't sell more trees than what you can replant.

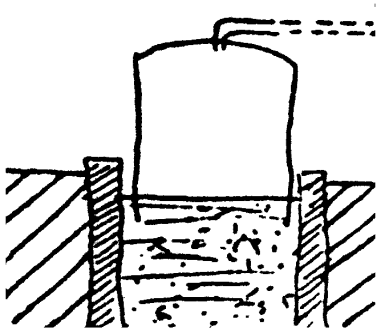
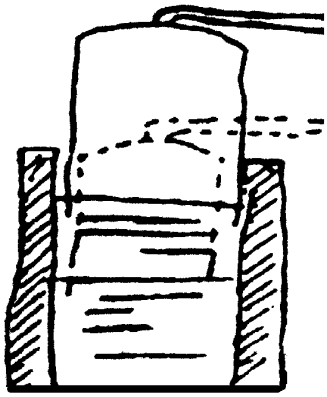
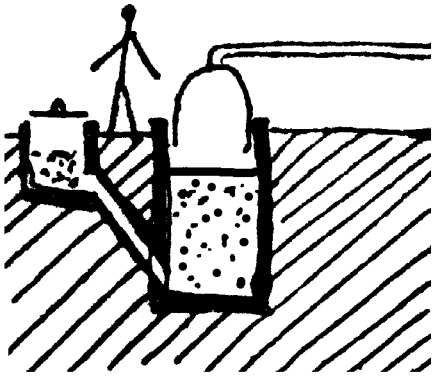
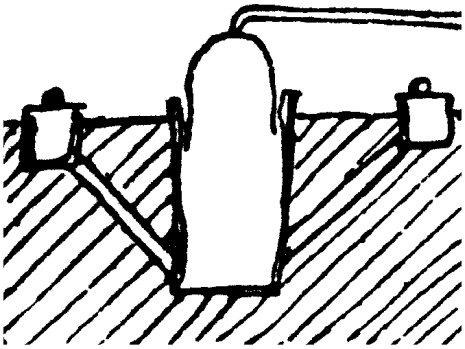
Biogas: production and use

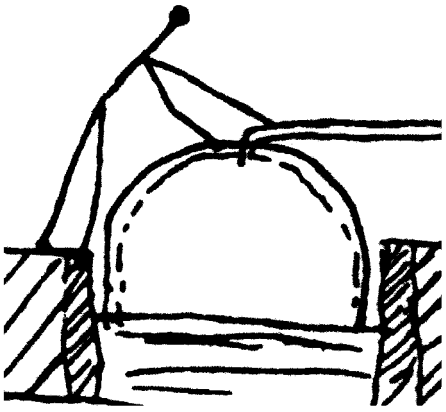
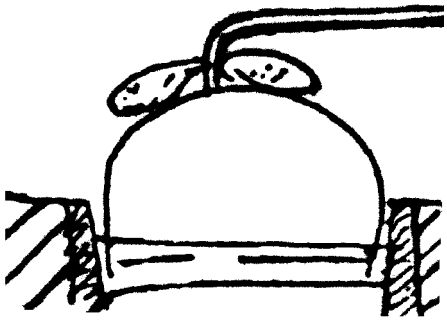
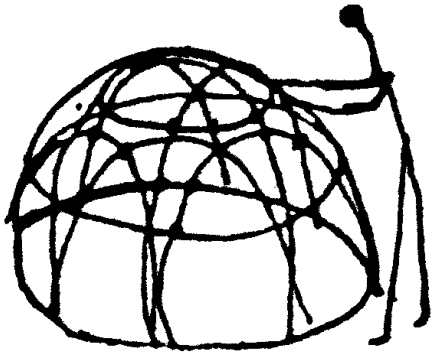
The system for producing biogas
can be easily fabricated by rural artisans.
Production of this convenient fuel gas
gives as a by-product a
high-grade compost for crops.

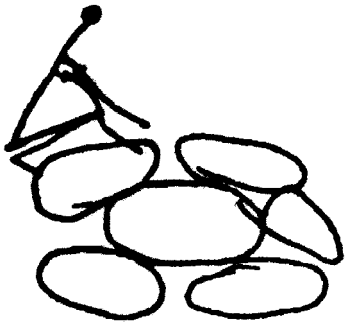
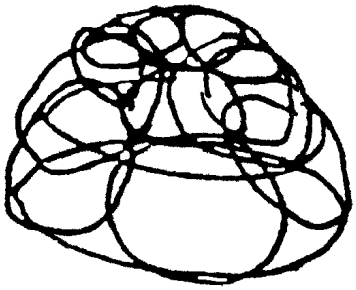
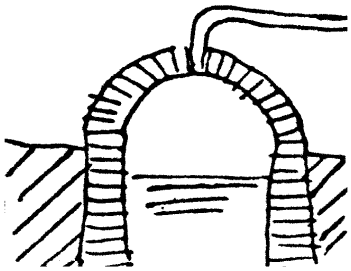
	Most fuels that you use at home (petrol, gas, charcoal)
	you can obtain from a shop.
	There is also other kinds of fuel which you can procure or produce yourself like firewood or biogas.

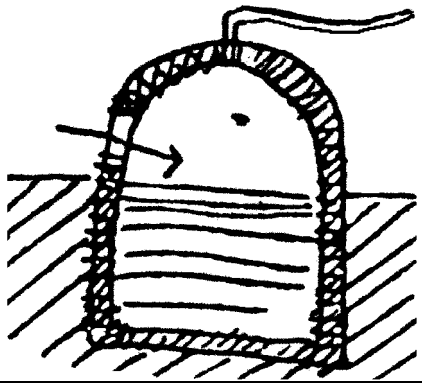
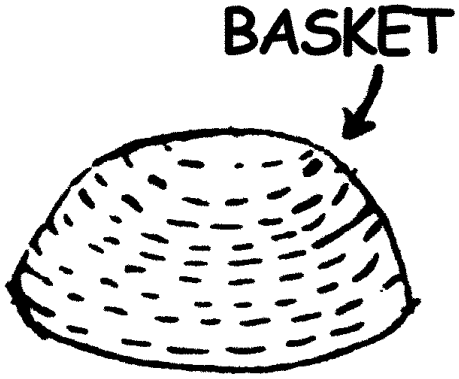
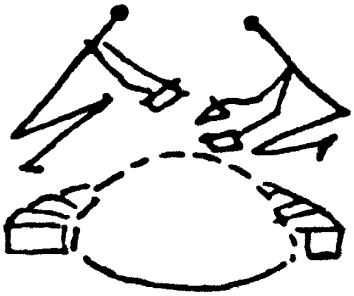
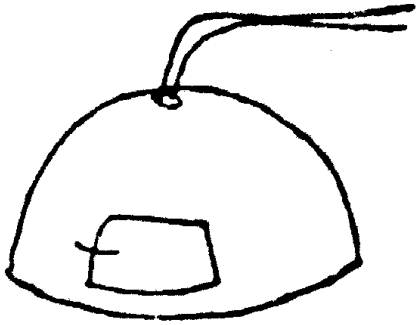
	Biogas is a product of fermentation; processes in rotting substances – like animal dung or vegetables.
	Anything that rots smells: because rotting materials liberate gases.
	Many of these gases are highly inflammable and can be made to serve as fuel.
	To produce such fuel gas you have to build a special equipment (which can be quite simple).

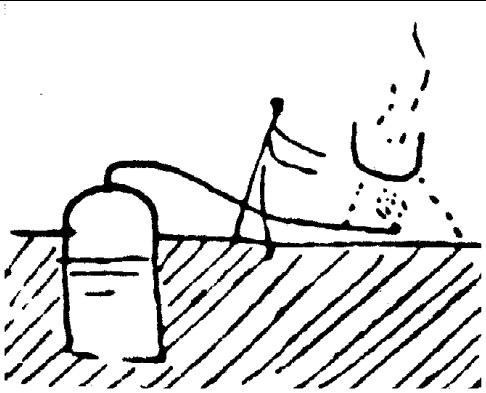
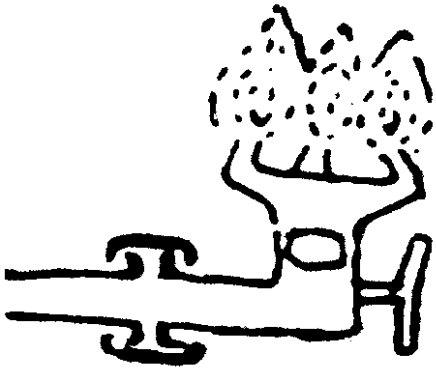
	The basic element of this equipment is a highly leak-proof pit (which can be made of concrete or brick or can be a special burnt clay container).
	The material, which would release the gas, should be left to rot in that pit, mixed with water at a certain temperature by using, say, sun-heated water.
	A dome should cover the digester pit.
	The gas accumulates in the upper part of this dome. The gas outlet is therefore always situated at the top.

	It is more advantageous if the collector-dome is made to 'float", that is, it rises when gas volume increases and sinks when it decreases.
	It would be ideal if the weight of the dome is such as to ensure pressure of the gas flowing through the delivery pipe.
	To feed the digester with the material the best solution is to build a smaller pit connected to the bottom of the digester by a large pipe.
	Similar arrangement should be made for letting out the digested material (for manure). Both the smaller pits should be closed by traps or covers.

	You can clean the three pits, when necessary, by lifting the dome or the covers.
	You can build the dome with bamboo sticks or splits and make it airtight with a tough but flexible plastic foil.
	Since such a dome would be too light to ensure gas pressure you can weight it down with a few heavy stones.
	The bamboo dome skeleton can be made of a number of arches supporting each other. Foot point of each arch should be placed under the highest point of the next arch.

	The arches should be tied at the intersections and several horizontal rings should be fixed from outside to make the structure strong.
	Another technique of making a dome is to use bamboo rings tied together to form a sort of a loose net.
	When you lift the net by the central ring it takes a dome shape. You fix a large ring to its bottom and strengthen it by fixing a few horizontal rings from inside.
	The plastic foils should be fixed on the skeleton from inside. The foil pieces should be sewn together after rolling in their edges.

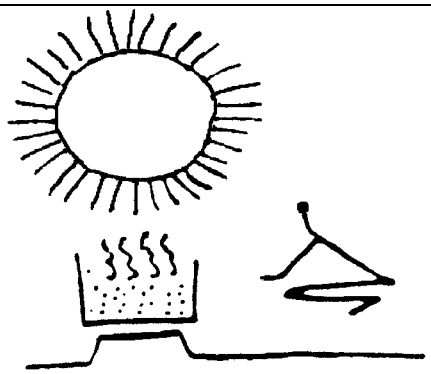
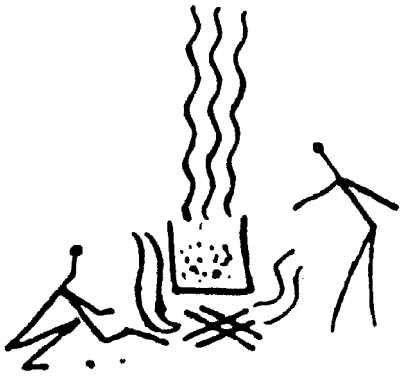
	To support the plastic foil cover, fix a few horizontal rings from inside the dome.
	To support the plastic foil cover, fix a few horizontal rings from inside the dome.
	A brick dome does not float but the required gas pressure can be assured by filling the digester pit with the generating mixture.
	The easiest way to build such a dome is by using a scaffolding having the dome's shape

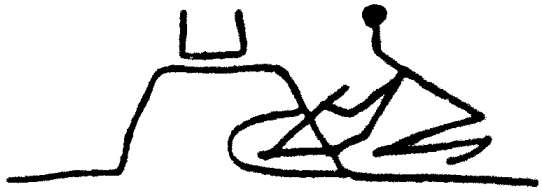
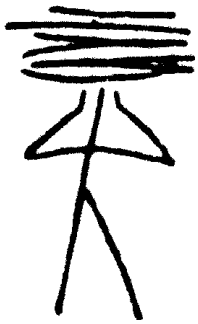
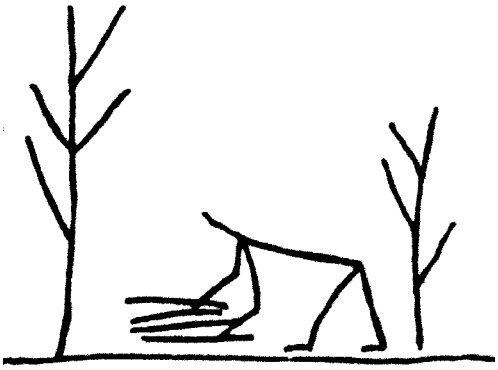
	and building the vault by making rings of brick around it starting from the bottom.
	The finished dome should have an opening at the ground level and a hole at the top for the outlet pipe.
	Once the set up is ready and sufficient gas has accumulated in the dome, join the outlet by a pipe to lead the gas to the kitchen or wherever you need it.
	All pipes and duct, wherever used, should be completely leak proof and the burner equipment (stove, lamp etc.) absolutely safe.

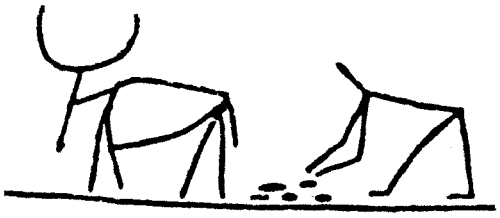
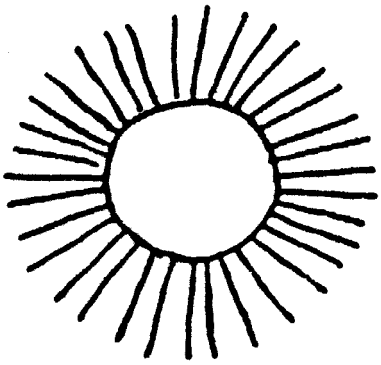
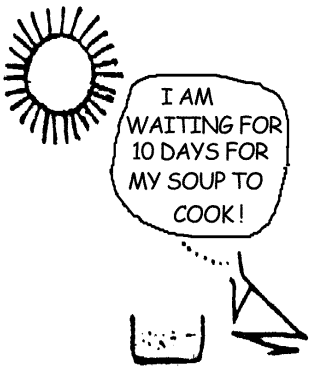
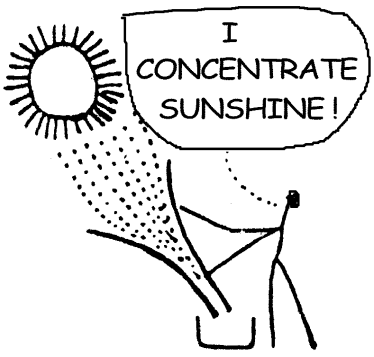
	Besides cooking and lighting in homes, biogas can be utilized by village craftsmen, smiths, potters, glassblowers etc.

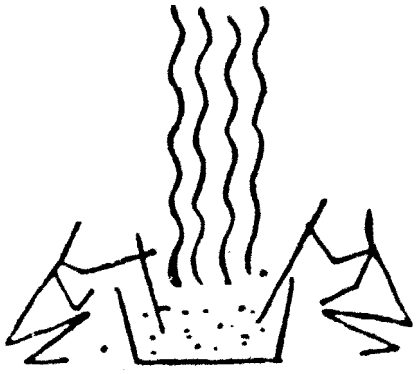
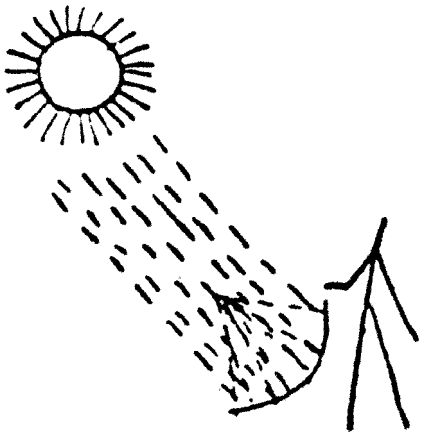
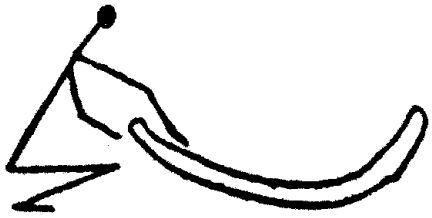
Cooking with the sun

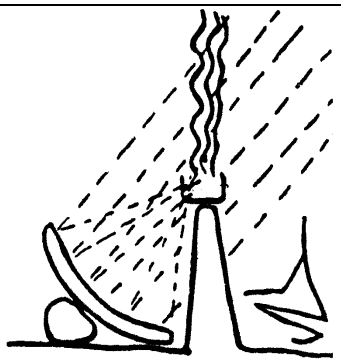
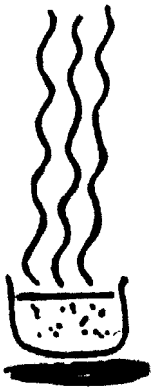
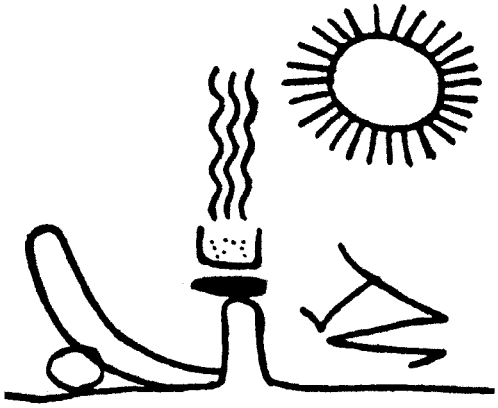
You can easily construct a solar cooker
for cooking your food.
It is based on concentrating
the sunrays in one place.

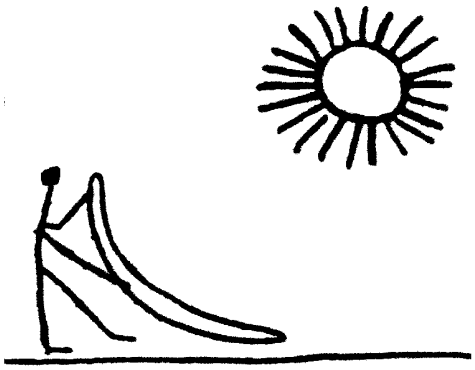
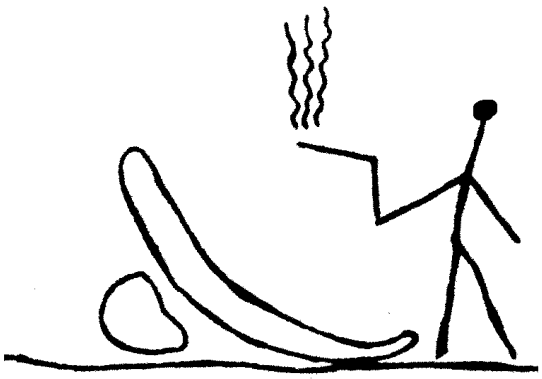
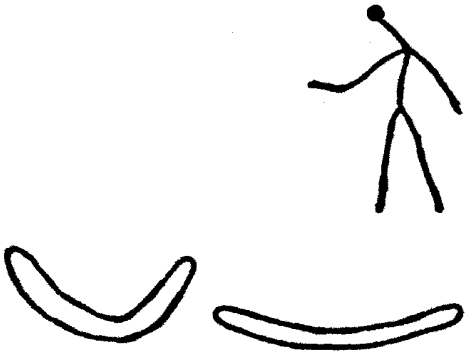
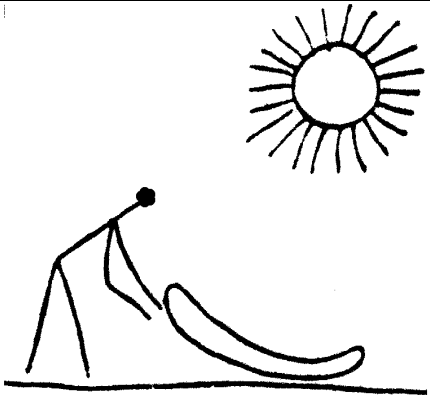
	One has to cook one's food. We eat most things after they are cooked.
	To prepare our food in most cases we use heat; boiling, roasting, baking, all these make use of heat.
	Stoves serve to prepare food through heating

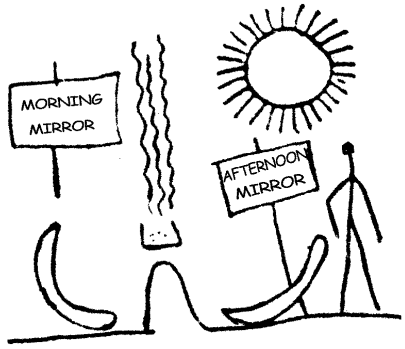
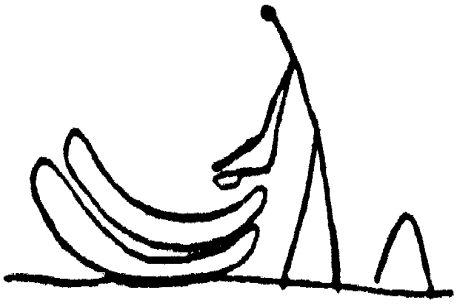
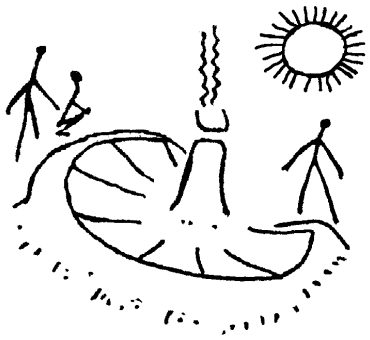
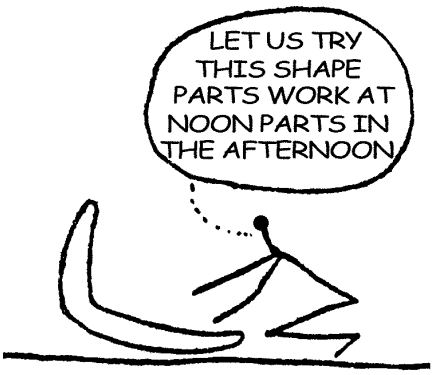
	Stoves have thus to be hot to make cooking possible. They are heated by some kind of fuel.
	Most fuels are expensive like petrol, coal, gas and electricity.
	There are some other fuels, which you can collect around where you live. Such fuels are wood and cow dung.
	But such fuels have drawbacks, too. If you cut too many twigs from a tree, this tree will soon die. Killing trees and shrubs leads to deserts.

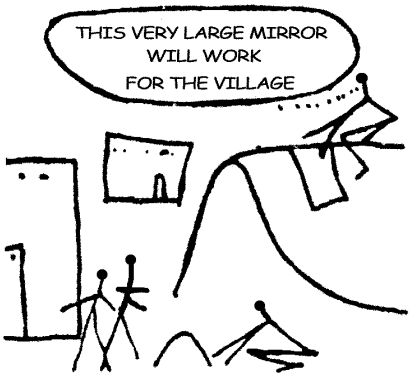
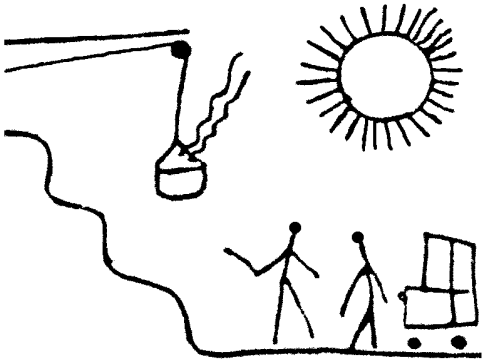
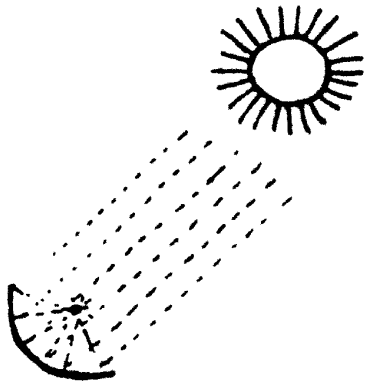
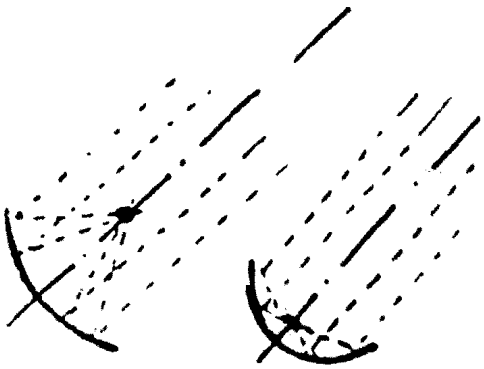
	Cow dung contains nutrients for soil. If these materials are not returned to the soil for years, the soil becomes poor.
	There is one kind of fuel, which you can find nearly everywhere. It is sunshine
	Sunshine in its natural state cannot be used to cook food. But you can concentrate it.
	If you can concentrate all the sunshine, which falls on your bed on to a surface, which is not larger than your hand,

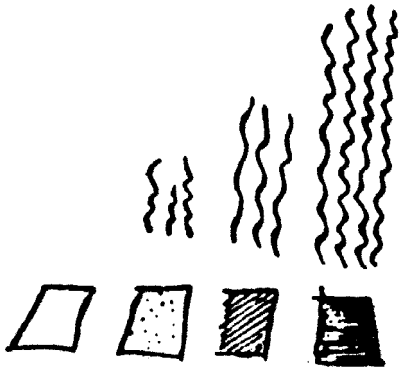
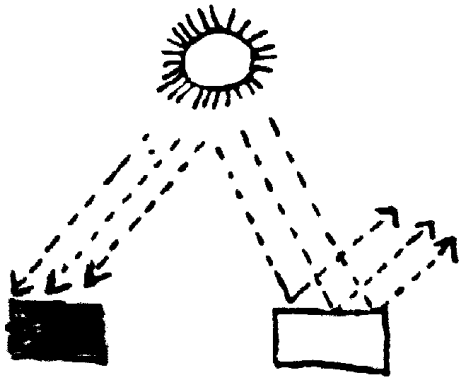
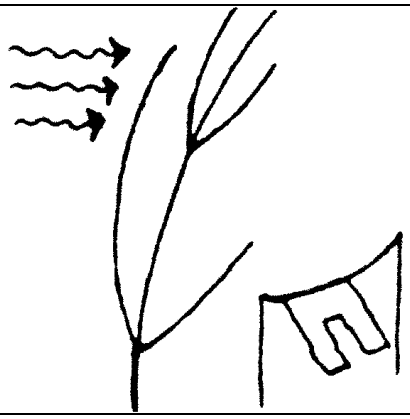
	you get enough heat to cook with.
	How to concentrate sunrays? You can do it, for example with cup shaped mirrors.
	You can model in clay a sort of large bowl (for example, 3 feet large).
	And you cover the inside of it with aluminum foils or with metalized plastic foils.

	This self-built curved mirror will concentrate the heat of the sun on your cooking pot.
	If you put into the area where the rays the are concentrated a black object for example, a blackened clay tray then
	this tray will get warm faster (than white objects) and you can use the heating plate for cooking food.
	You should experiment with your stove. You might find interesting uses for it.

	For example, you will find that you can best use your curved mirror when you direct its full face against the sun.
	You will find, by experimenting, that the hot spot is situated over the mirror,
	You will also find, how the shape of the mirror influences the location of the spot. You are becoming a scientist.
	You can assure the best conditions in your stove by moving your mirror to face the sun.

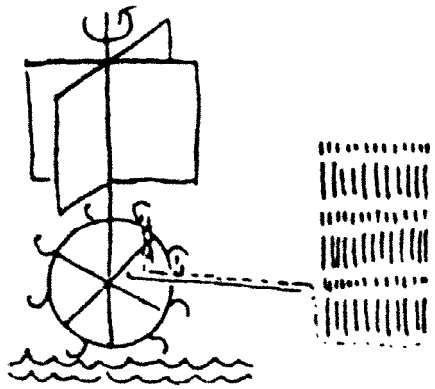
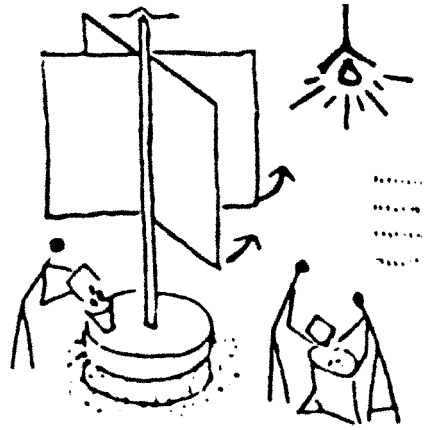
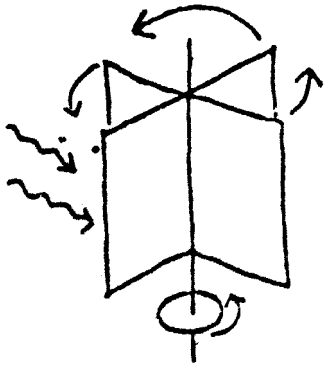
	You can do otherwise, too, by building several fixed mirrors around the stove: each of them will be efficient at a different period of the day.
	Several mirrors are not really more expensive than one since you do the work: the metal foil is the only thing that you have to buy in a shop.
	You can try and build in the same way a continuous mirror around the heating place. There will be a part of the mirror, which will act at any hour of the day.
	You have to experiment with the shape and position of the mirrors in order to find the best ones.

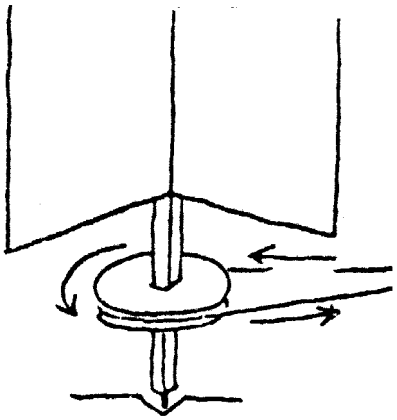
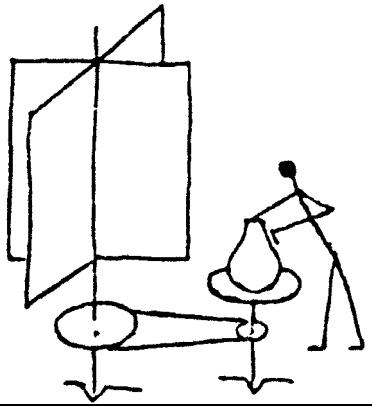
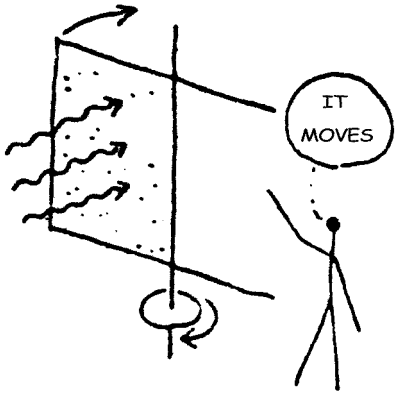
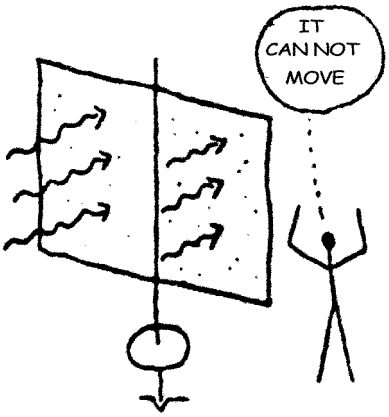
	You and your neighbors can co-operate together trying various conceptions of solar stoves.
	To build a solar stove you applied two simple laws of physics:
	1. Mirrors reflect sunrays and concave (cup-form) mirrors do it best, making all rays to meet at one point (focus).
	The distance of the focus above the concave mirror varies with the form of the mirror. But it is always situated on the (imaginary) axis of the mirror.

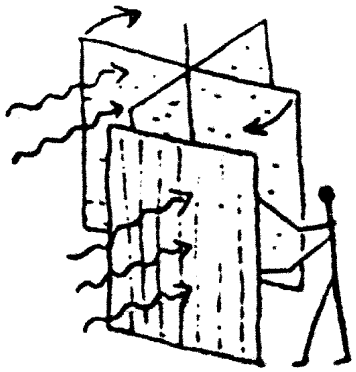
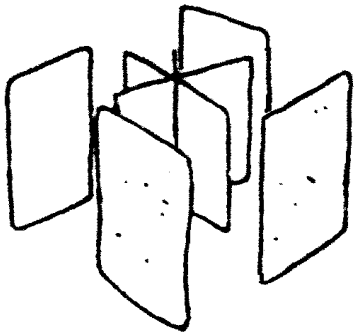
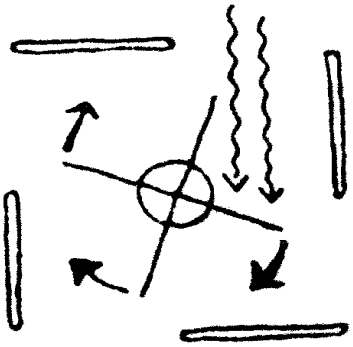
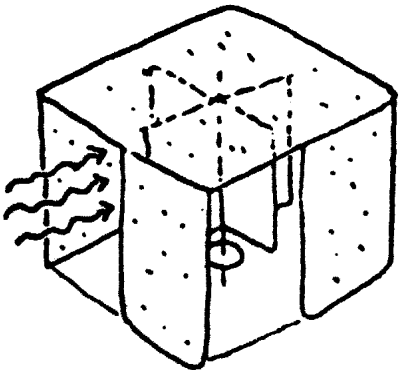
	2. Black things get warmer faster than white things when exposed to sunrays.
	Differently colored objects made of different materials get warm differently when exposed to the sun.
	Black objects absorb heat and get warmer quickly than white objects, which reflect heat.

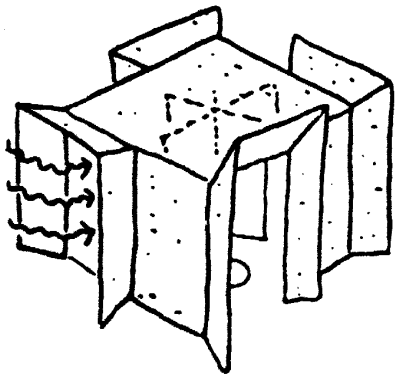
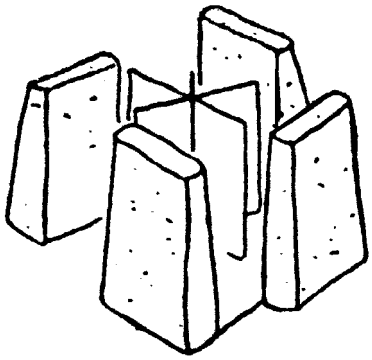
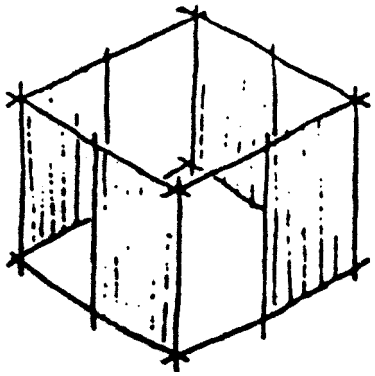
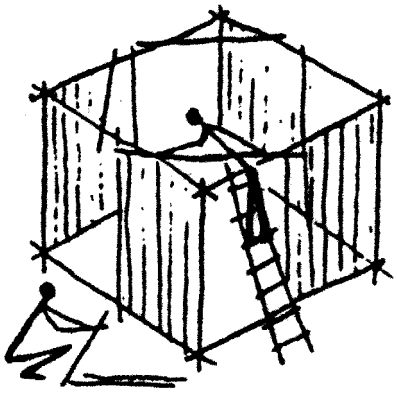
Harnessing the wind

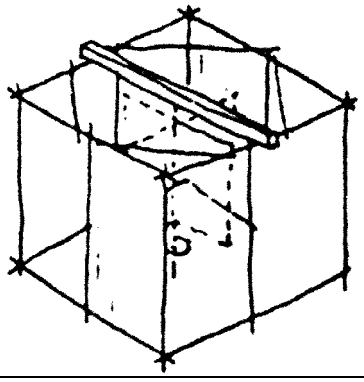
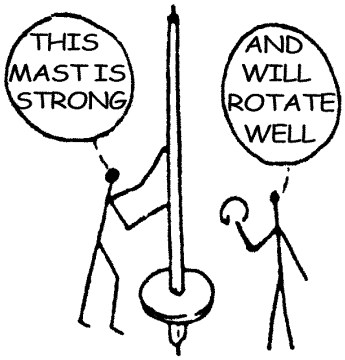
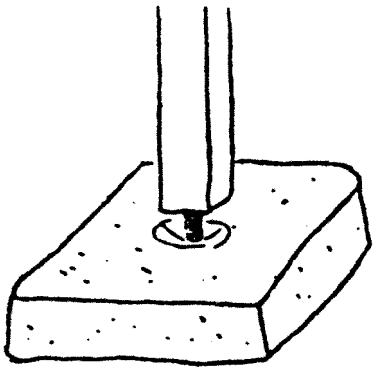
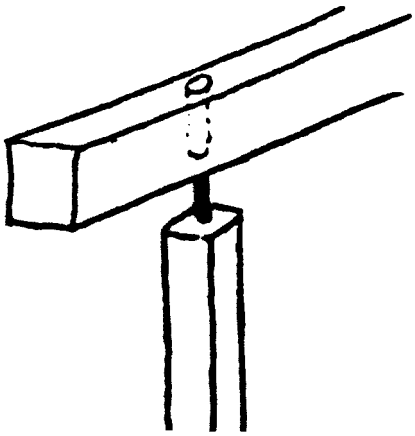
If you happen to live in a windy terrain
you can harness wind power
using a Persian windmill,
to drive grain mills, water-lifting pumps,
power generators, etc.

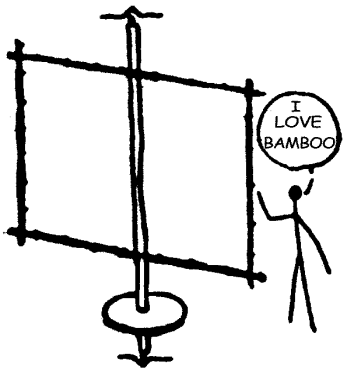
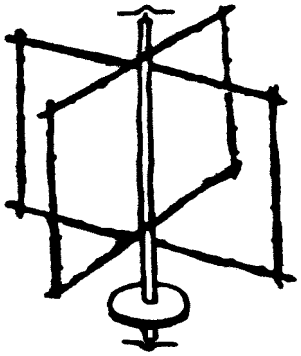
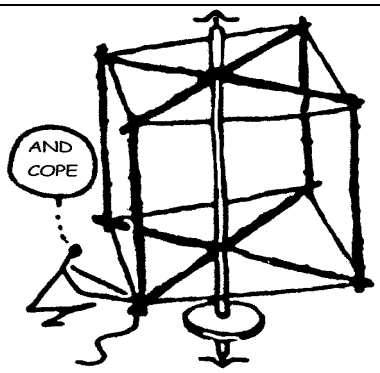
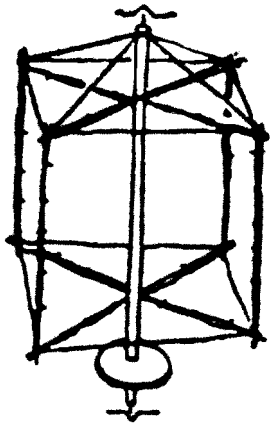
	If you live in a region with regular wind, much of the work what you do yourself or with the help of an animal or a machine
	can be performed with the help of a windmill. A windmill can be used to lift water to irrigate your fields,
	or to grind the grain or to run various tools. It can also be used to produce electricity.

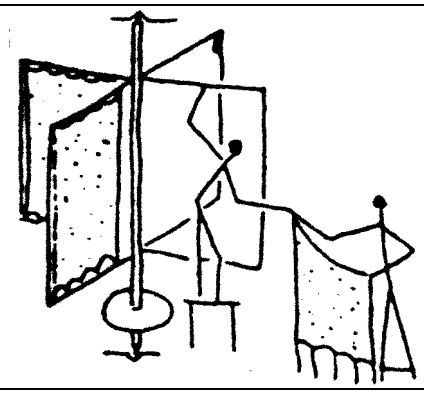
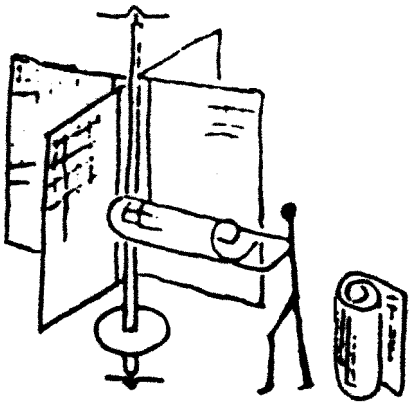
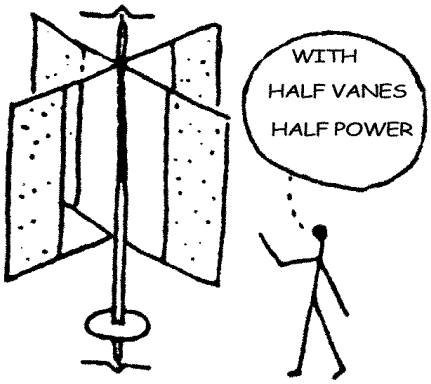
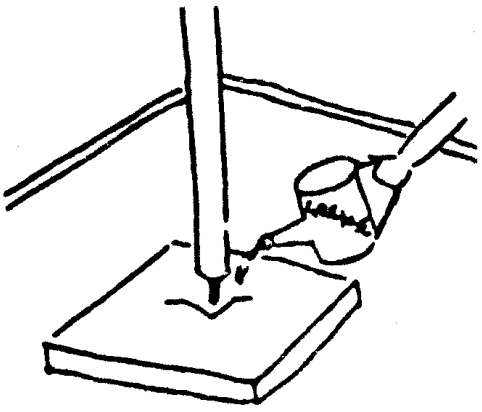
	A windmill rotates when there is wind
	and transforms the power of the wind into the rotation of the wheel.
	This rotating wheel can drive various tools just like a man, an animal or a machine would do.
	If you want to build a windmill you have to know some basic facts: If the wind pushes on one vane

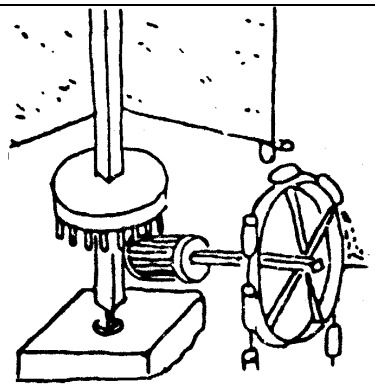
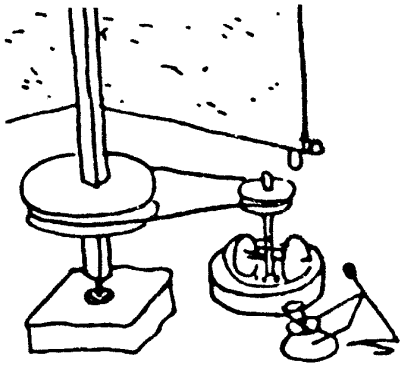
	it simultaneously brakes on the opposite vane so that the windmill cannot rotate.
	The windmill will rotate only when the wind pushes the vane on one side while the opposite vane is protected from the wind by a screen or a wall.
	The screens or walls for the vanes are immovable parts of windmills. If you build such screens/walls on four sides
	the windmill can rotate irrespective of the wind direction. This type of windmill is called the "Persian windmill".

	A roof makes the structure more solid and increases the effect of the wind.
	With funnel-like openings you can catch even more wind power.
	The screens can be made of mud or brick walls, which are heavy, and stable
	or bamboo mats attached to a frame made of wooden or bamboo poles.

	The latter structure will have to be stiffened by diagonal poles, so that it can withstand the wind pressure
	and also bear a beam to support the vertical axis carrying the rotating part of the windmill.
	The vertical axis should be strong and capable of rotating It should, therefore, stand on the smallest possible base area like a metal point turning on a stone foundation smoothly.
	The top of the axis can be held by a drill hole or a ring on the beam.

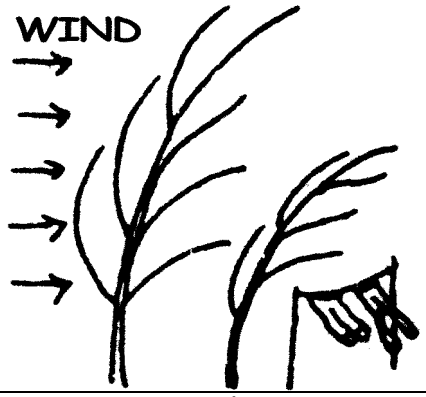
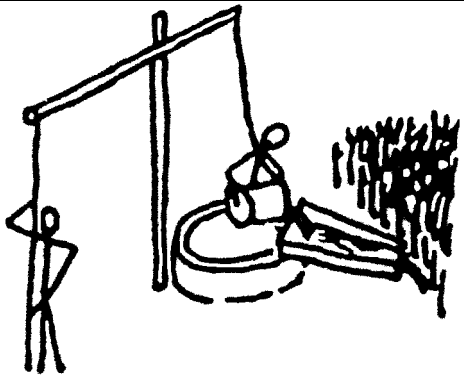
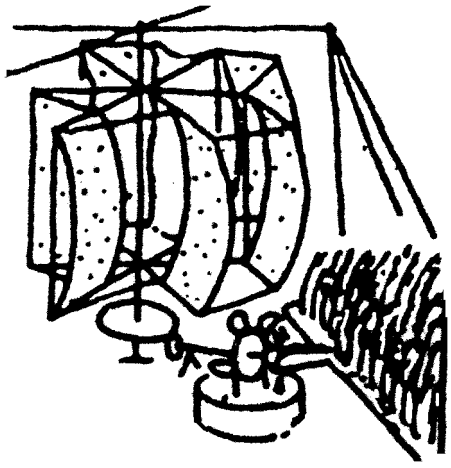
	The vertical axis or mast carries frames.
	For the Persian windmill two frames are sufficient.
	If the frames are joined at the top and bottom by ropes or poles
	and hung from the top of the mast, the construction would be more stable.

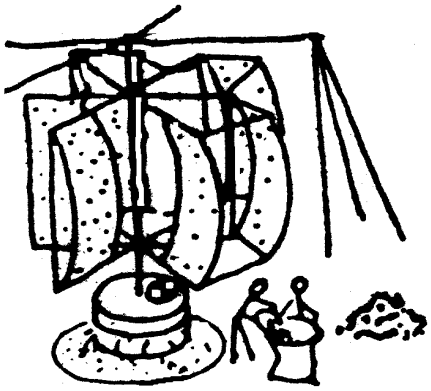
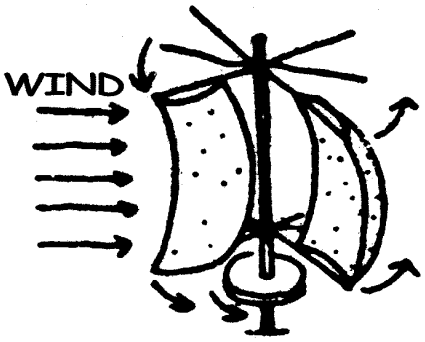
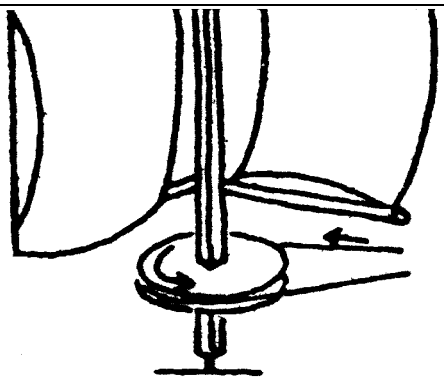
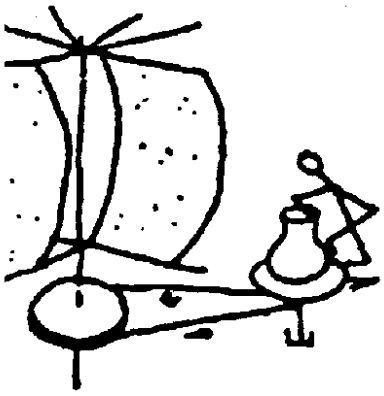
	The frame carries vanes made of fabric
	or of bamboo mats or of any other light material.
	The power of your windmill will depend on the size of the vanes
	and the smooth rotation of the windmill.

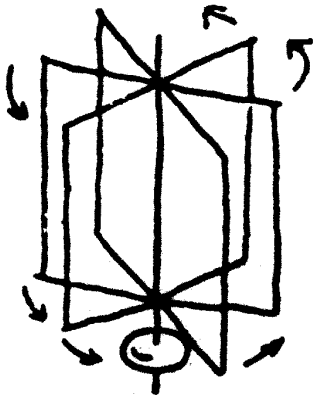
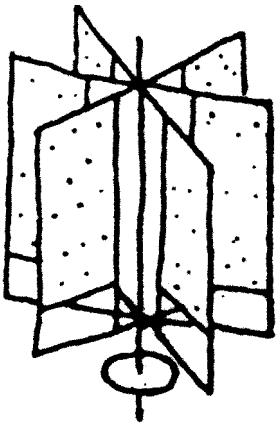
	The rotating wheel of a windmill thus becomes a source of energy. It can drive different machines like a water lift,
	or an oil mill – or even an electrical generator.

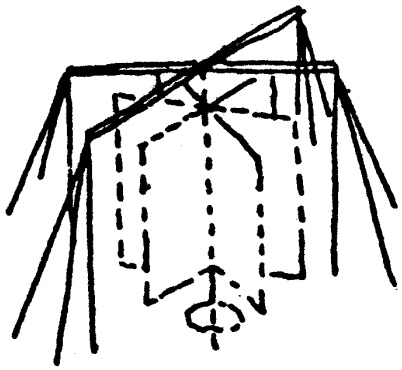
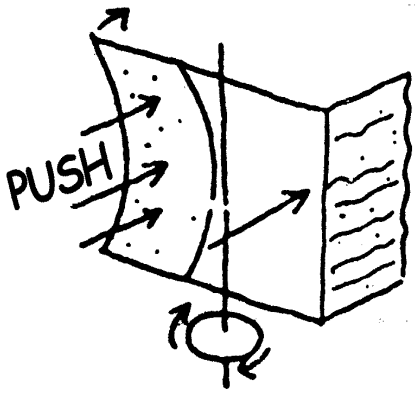
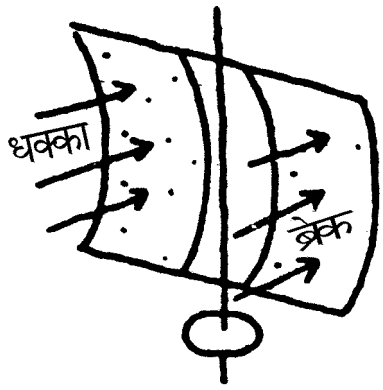
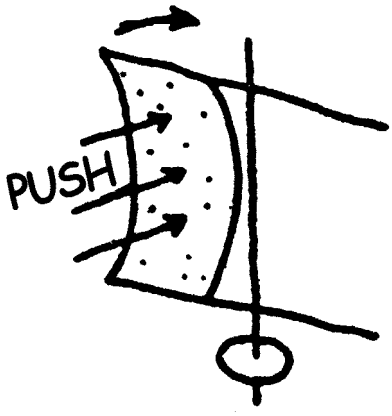
Let the wind work for you

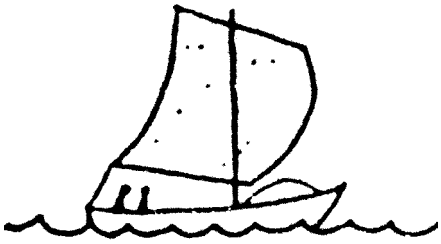
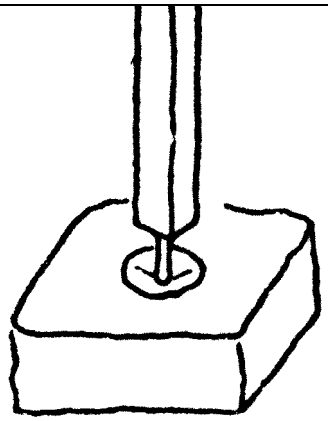
The wind power could be easily tapped using a windmill of Chinese design. Once assembled, it works for us continuously without needing much attention.

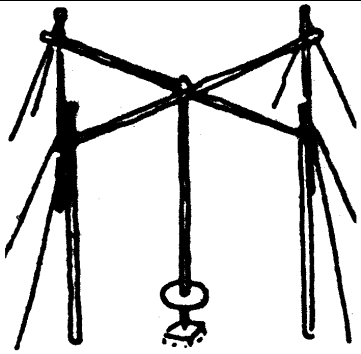
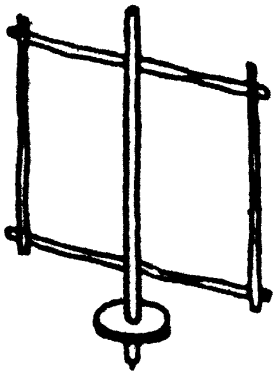
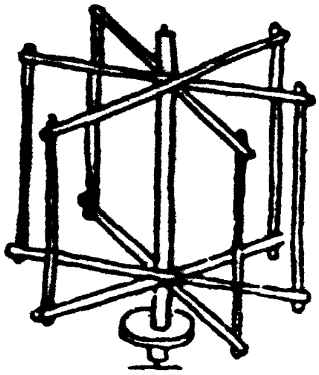
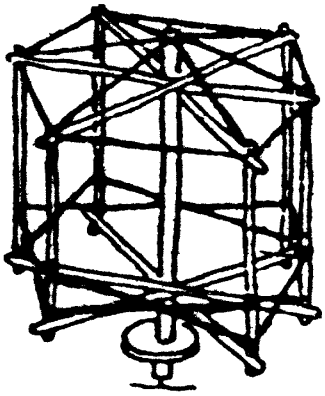
	If you live in a region with regular wind
	then work which usually has to be done by yourself, an animal or a machine
	could be performed by wind with the help of a windmill. A windmill can be used to lift water to irrigate your field,

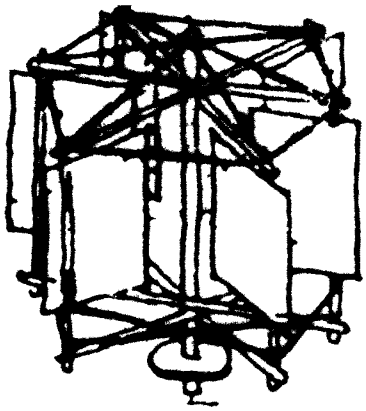
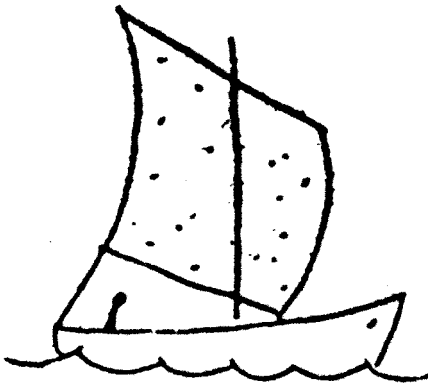
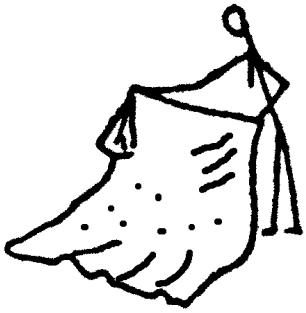
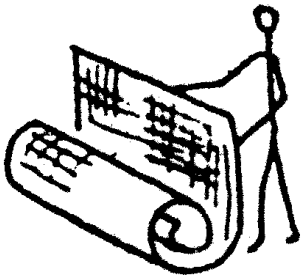
	to grind the grain or to run various tools.
	A windmill rotates in the wind.
	It transforms the wind power into the rotational power of the wheel.
	This rotating wheel can drive various tools, the same way they are driven by a man, an animal or a machine.

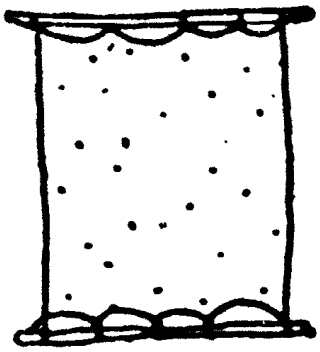
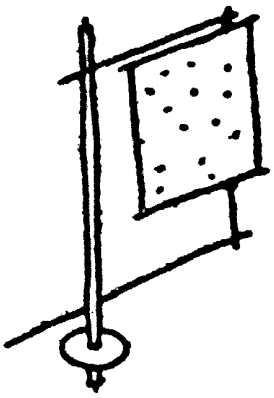
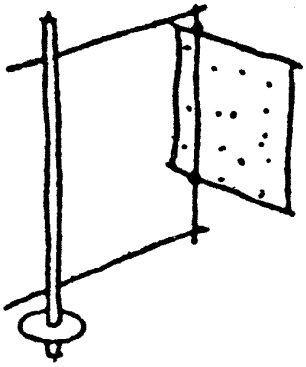
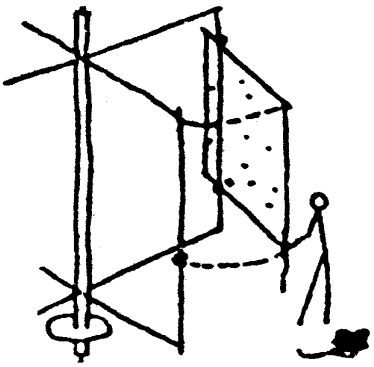
	You can build a windmill yourself, if you know its parts and how they are to be assembled.
	The windmill basically consists of a rotating part –
	a vertical axis with a wheel –
	to which vanes are attached

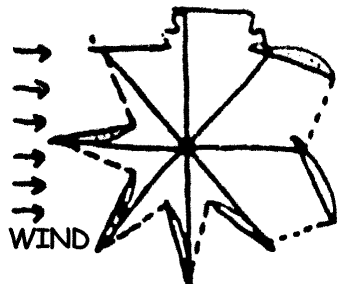
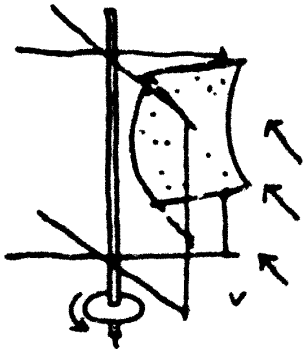
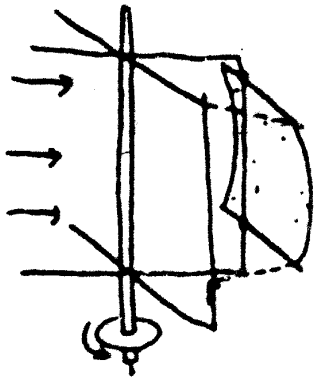
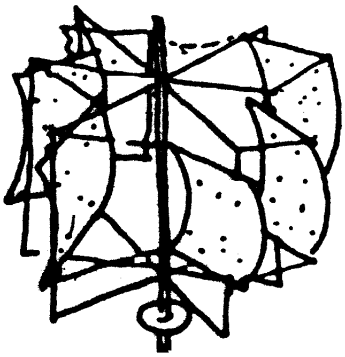
	and an immovable frame, which holds the rotating part in position.
	If you want to build a windmill you must know that, in a simple vane arrangement, if the wind pushes on one vane
	it simultaneously brakes on the opposite vane so that the windmill cannot rotate.
	The windmill will rotate only if the vane on the pushing side does catch the wind and the vane on the braking side lets the wind pass.

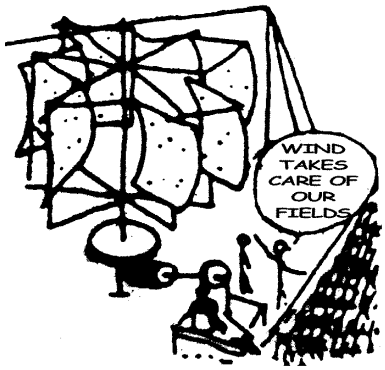
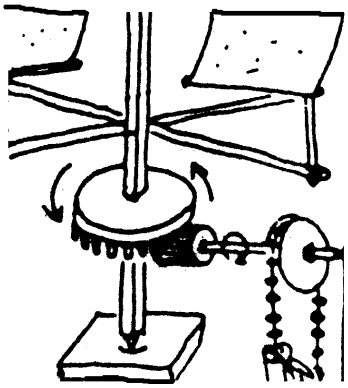
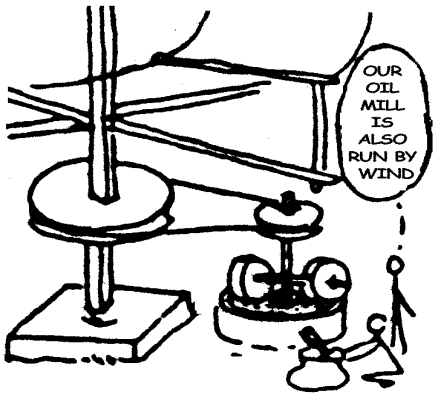
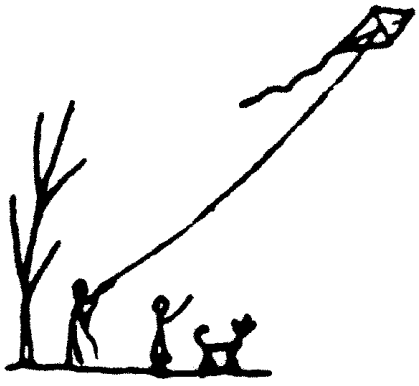
	The Chinese solved this problem by using sails for vanes. The wind swings the sails into the right position as it does with the sail of a boat.
English slide missing. 217	The mast has to be strong, as it has to carry the whole construction. And it has also to rotate easily.
	The mast should turn on the smallest possible surface. If possible, it should end in a metal point turning on a stone foundation
	and a ring or a conical shoe should hold it at its top.

	The ring or shoe is held in position by an immovable frame.
	To the mast are then attached movable frames made, for example, of bamboo.
	There are 3-4 such frames.
	The construction would be more stable if the frames are joined at the top and at the bottom by ropes or bars.

	These frames would carry about six or eight sails.
	Like the sails of a boat,
	the sails of a windmill could be made of fabric,
	or of mats of split bamboo or of straw.

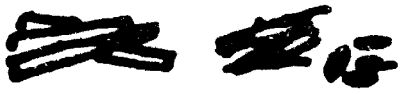
	The fabric of the mat is stretched between two bars.
	If the sail is attached on the outer side of the frame
	in such a way that it can swing like a door (which can be closed or opened)
	and the two free corners of the sail are connected with the next frame by ropes

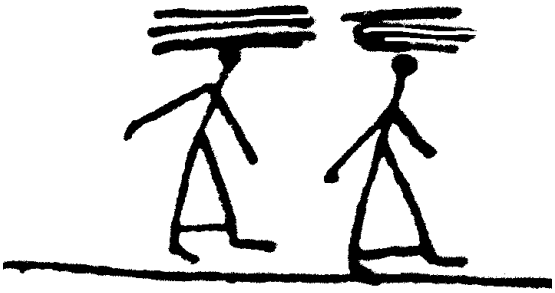
	the wind itself can change the position of the sails to achieve the maximum possible pushing effect.
	Fixed in this way the sail will catch the wind when it stands inside
	as well as when it stands outside the frame. In both positions the ropes are stretched.
	If the ropes are not stretched the sail does not catch any wind and there is no braking effect.

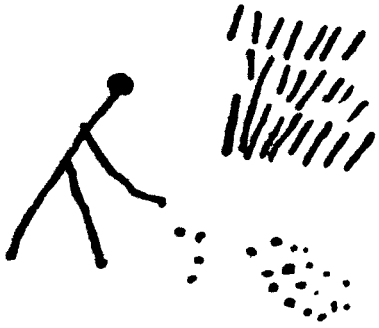
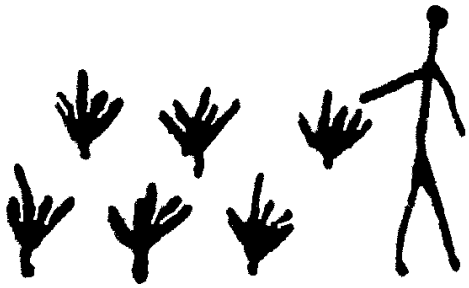
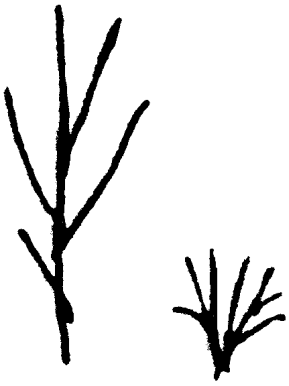
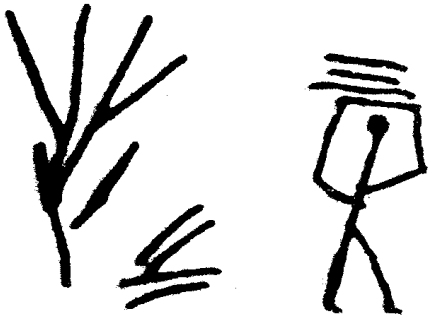
	Such a windmill will catch the maximum possible wind power independent of the direction of the wind.
	Whenever the wind blows the windmill can perform work.
	The rotating wheel becomes the source of ‘energy’.
	It can drive a variety of tools and machines. It can thus go on working for you without your having to spend anything on energy.

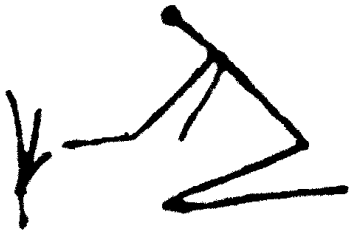
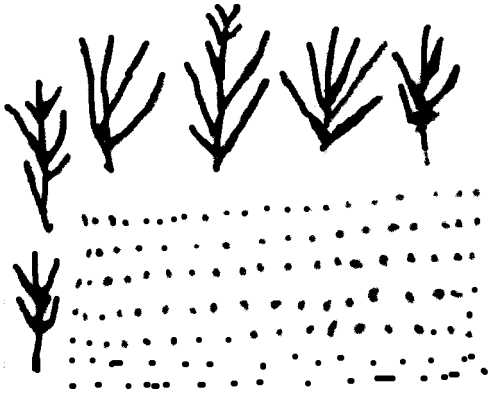
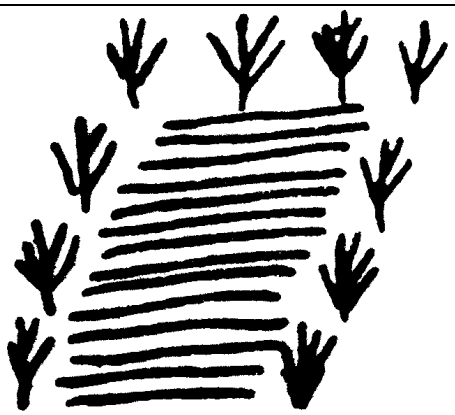
Grow your own fuel for cooking

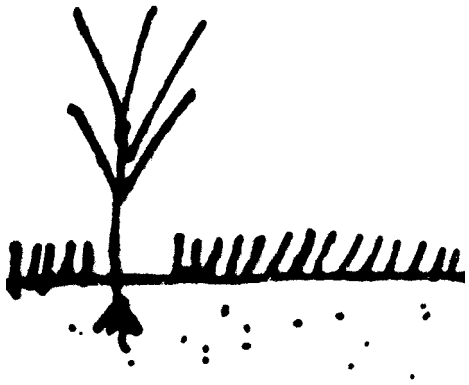
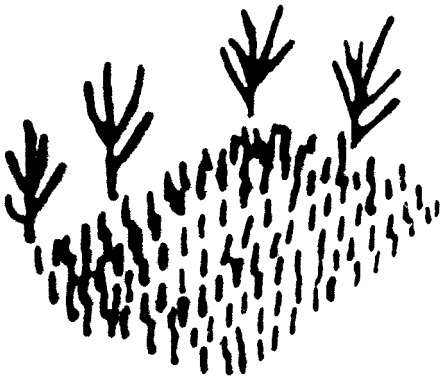
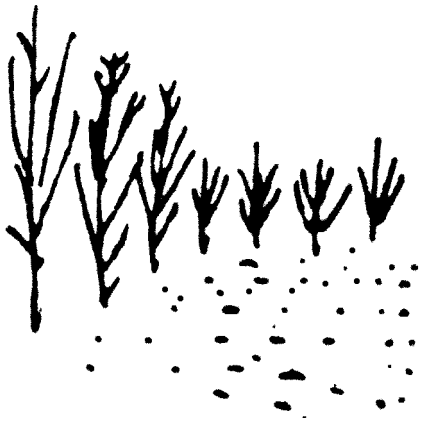
Some fuel producing trees
could be advantageously grown
along with the regular crops.

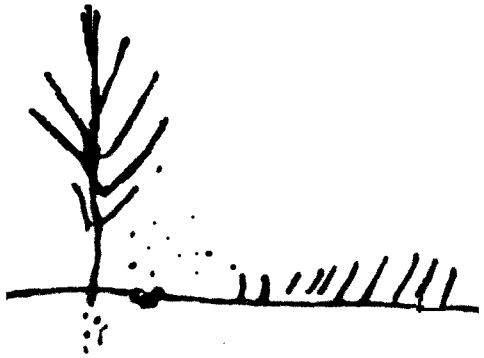
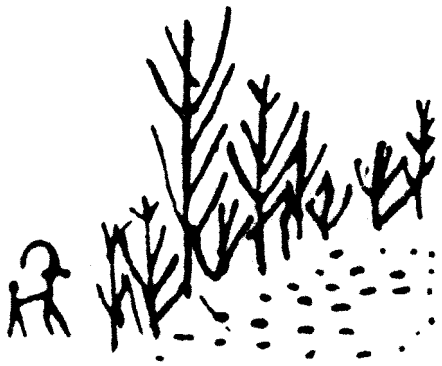
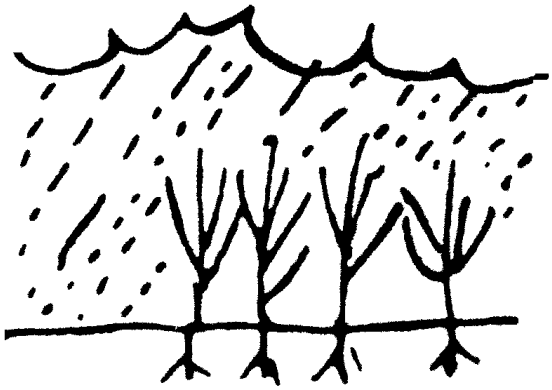
	You cannot cook your food without fire.
	So, in order to have hot food you burn wood, bush or charcoal,
	cow dung and

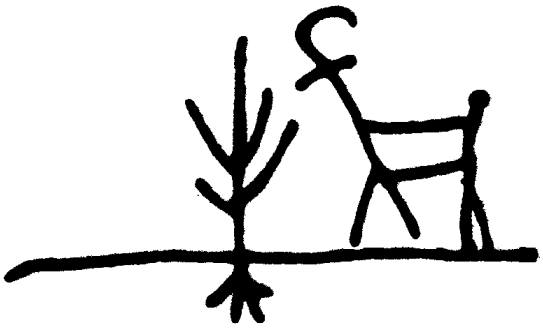
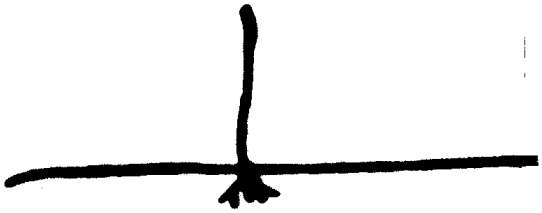
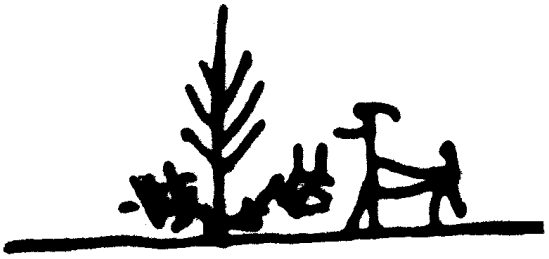
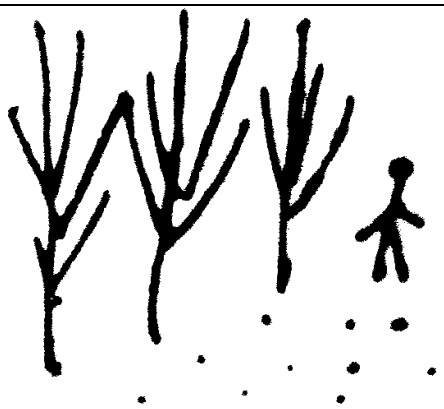
	petrol or gas
	Cheap fuel to make fire is difficult to find.
	Wood and charcoal are expensive and so are petrol and gas.
	Bush wood or straw you have to bring home often from far away.

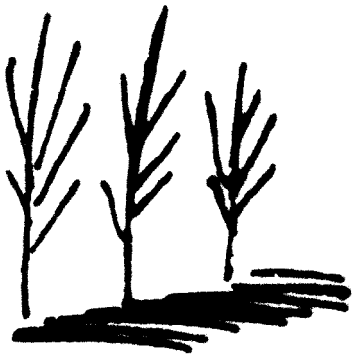
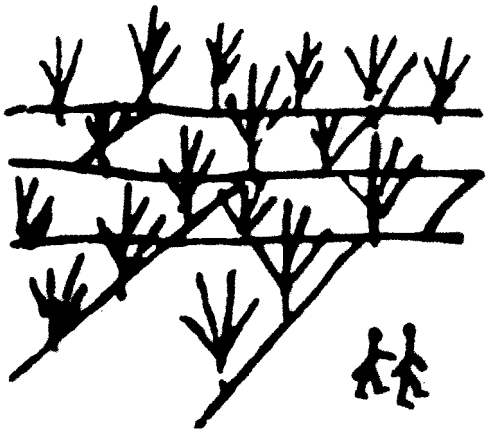
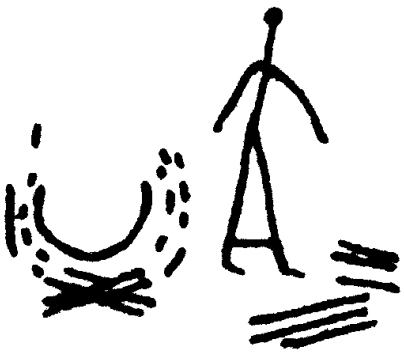
	As for cow dung, it should be better used for fertilizing your land instead of making fire.
	If you have a garden or a field you can grow your own fuel.
	There are many fast growing trees or shrubs,
	which can assure your firewood, supply for many years

	if you know how to collect your firewood crop (how many branches and how often).
	Firewood is a crop of value and you can plant firewood-yielding plants (trees or shrubs)
	in the form of hedges around your garden,
	or around your field.

	Planting firewood crop around your land
	does not use up too much space
	and all the space inside the hedge stays reserved
	for your other crops.

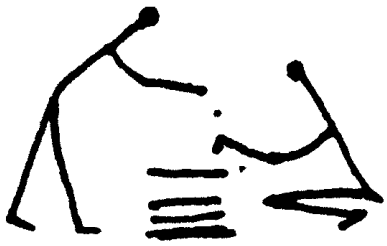
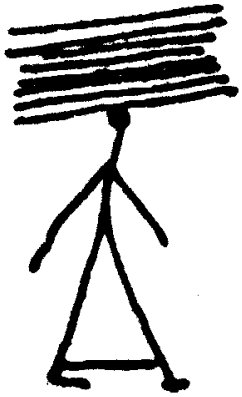
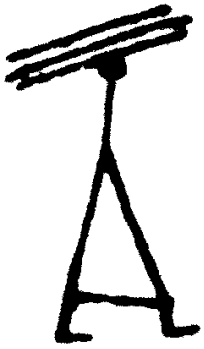
	Hedges of firewood crop have other advantages, too:
	Some firewood crops improve your land and soil (by supplying nitrogen and falling foliage).
	These hedges also keep out stray animals, which would otherwise damage your fields.
	They also limit erosion, and help maintain more humidity in the soil.

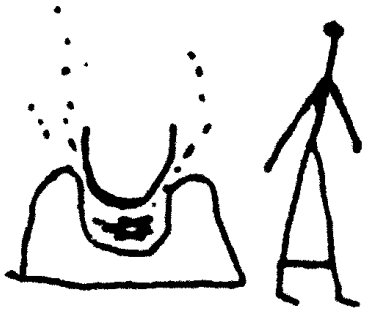
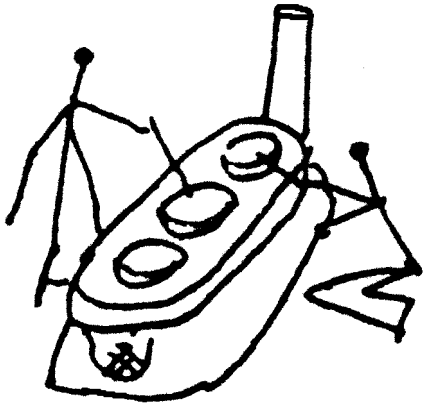
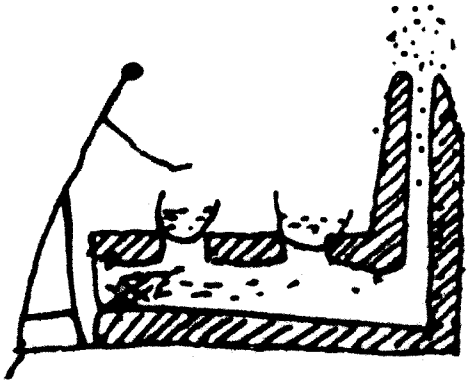
	When planting trees or bushes for firewood, you have to protect the young plants against herbivores,
	who could damage the saplings.
	You can use for this purpose barriers, made out of dry thistle, for example.
	Finally, hedges of firewood crops once sufficiently grown

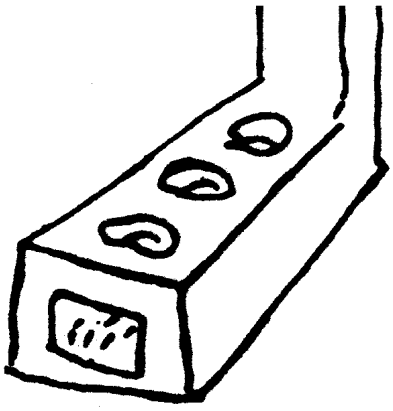
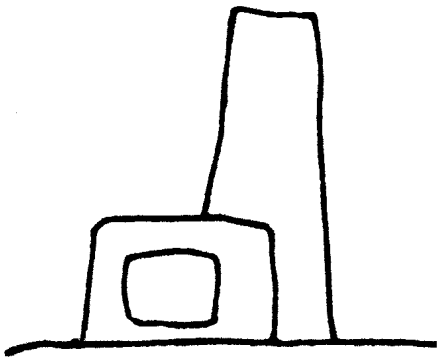
	give shadow
	where it is nice to rest during the hot hours.
	It might be a good idea to combine the various crops
	in your fields with a few trees for firewood.

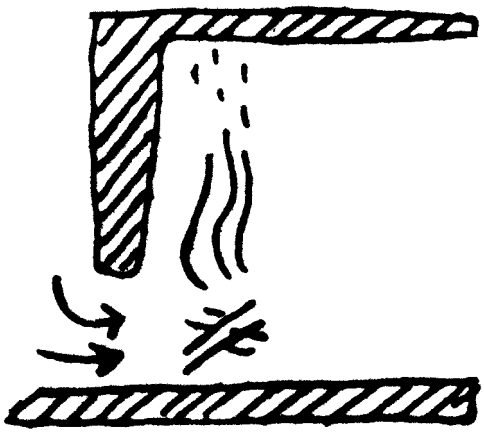
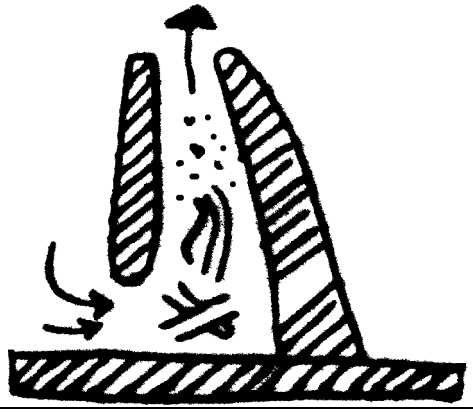
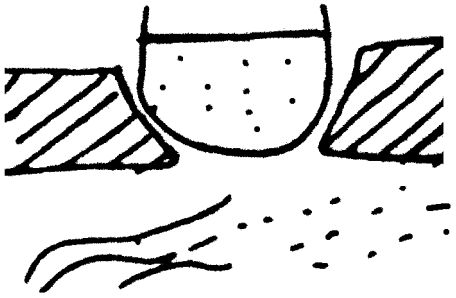
A hearth that uses less fuel

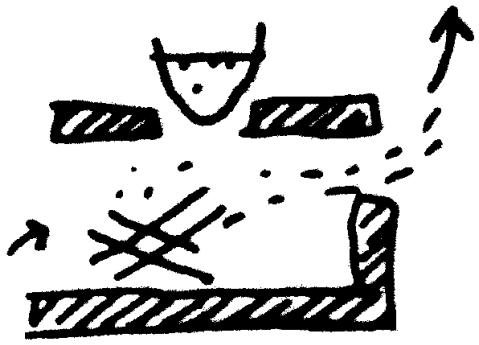
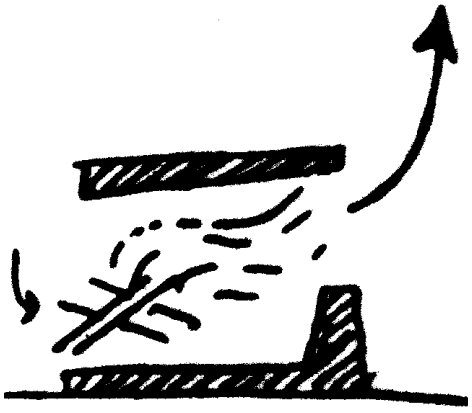
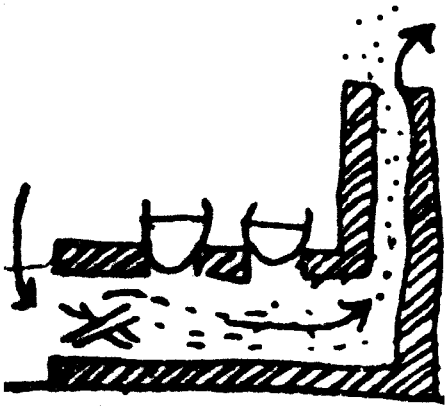
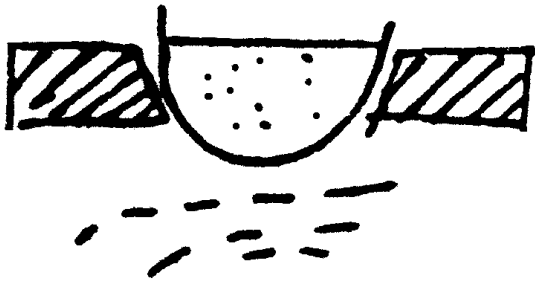
You can save your fuel
by designing a longish hearth
having a little raised
fireplace with a gentle slope.

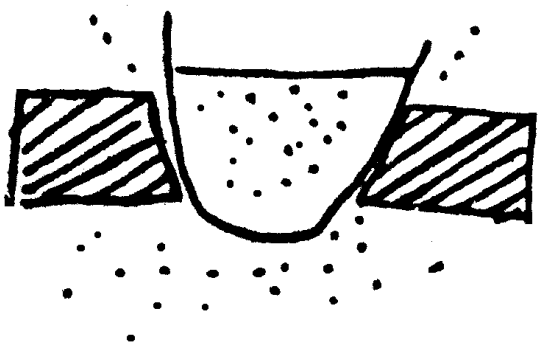
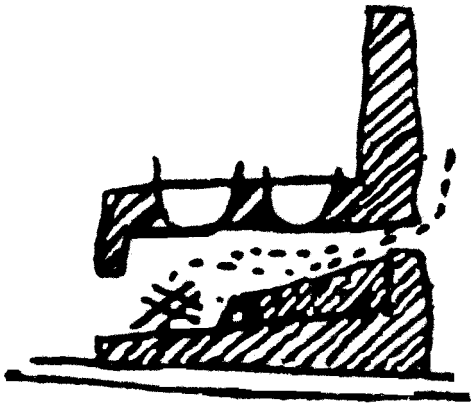
	For cooking your meals you use fuel, which is always expensive,
	in terms of cash,
	or of labor.

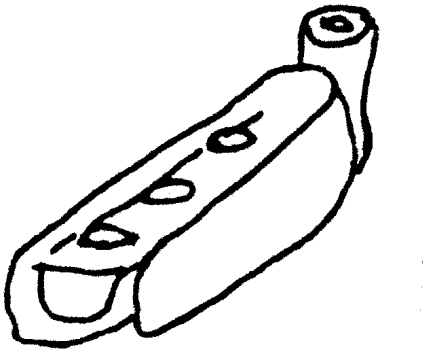
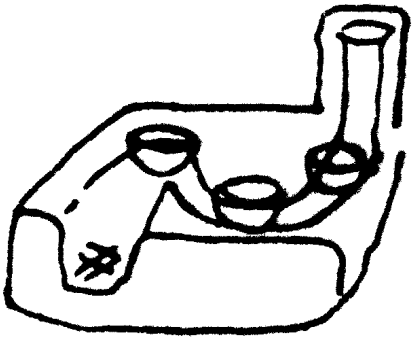
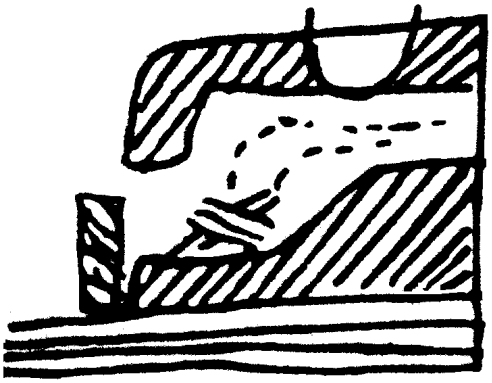
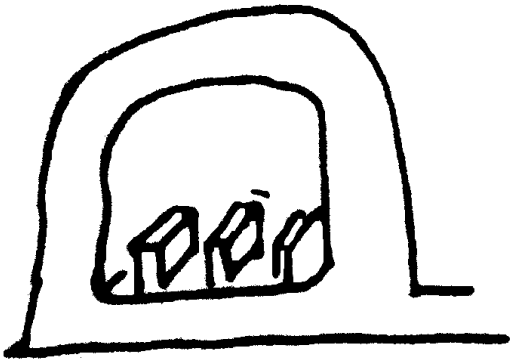
	If you could reduce the quantity of fuel needed you could save both cash and labor.
	To reduce the quantity of fuel used to cook the same quantity of meal you should improve the hearth you use.
	You can cook your meal in several pots even on a smaller fire,

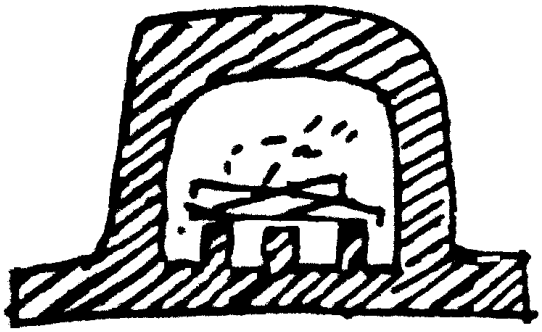
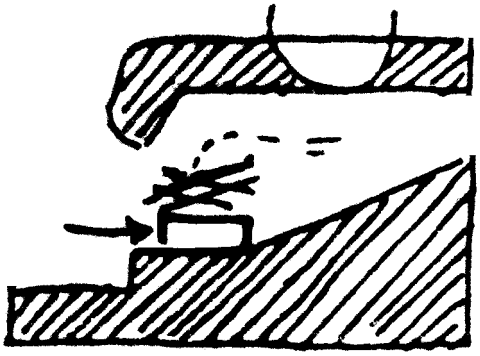
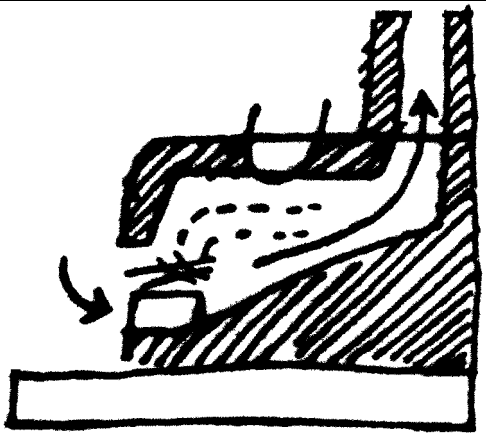
	if you make your hearth in the form of a long horizontal channel,
	Wherein the hot flame goes from the fireplace towards the smoke outlet.
	Let us see how such a hearth works.

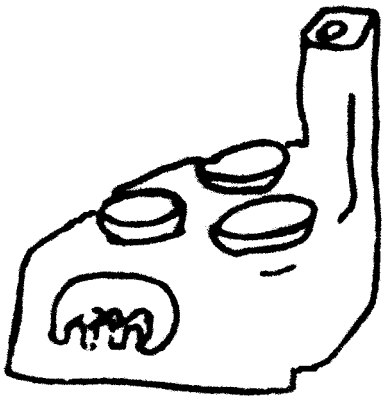
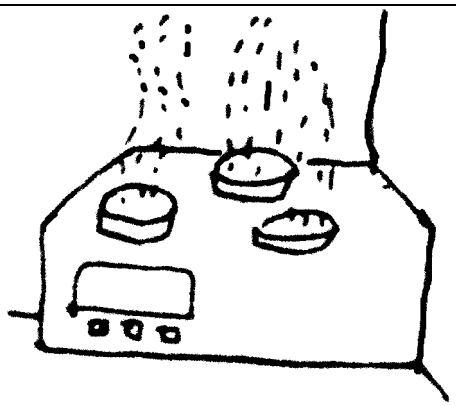
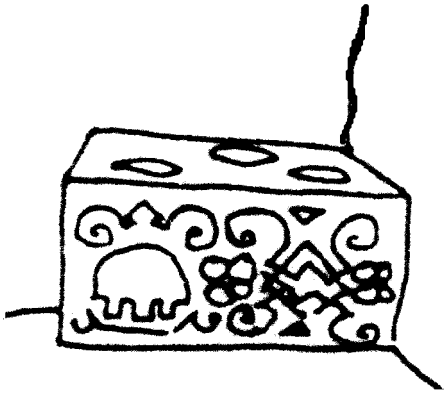
	You have first a place where the fire burns.
	For the fire to burn an air supply is necessary, and so near this fire is an air-inlet.
	Hot smoke and flames of the fire tend toward a smoke-outlet. The draft between the air-inlet and smoke outlet makes the fire burn faster, or slower.

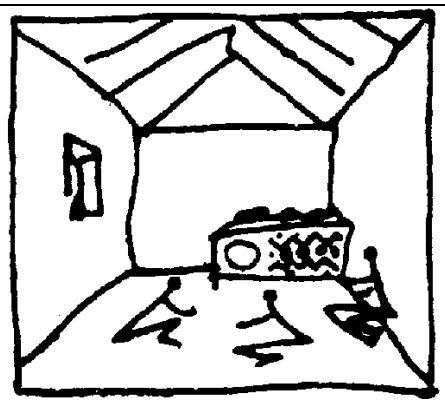
	The pots with meals are heated by the flames and also by the hot smoke gases generated by the fire.
	Flames and smoke gases stream toward the chimney.
	Your pots, in order to get heated, have to be placed on the route of the gases.
	It is important, that the pots should expose the largest possible surface to the flames and the hot gases.

	And it is also important that the hot gases should not escape between the pot and the hearth.
	The smoke-outlet (chimney) should lead outside the house and the air-inlet should be easy to regulate.
	As for the heat-channel leading from inlet to outlet, it should rise in a gentle slope toward the outlet.
	You can build such a hearth out of dry mud.

	The heating channel can be straight,
	or serpentine.
	The air-inlet can be regulated by obstructing it more or less by means of mud blocks.
	The fireplace can work better if it is slightly raised,

	for example, on a few bricks,
	in order to let the ashes fall down to the bottom.
	Such a disposition facilitates air passage from under the fire:

	the draft becomes better, and the fire smokes less.
	An earthen hearth (a *chulha*) built this way keeps the heat longer
	and thus keeps your meal warm.

	If the hearth is decorated with a painting or with mud relief it might be the pride of your house.