

Workshop: Designing Roots

On July 2, 1997, AAI held a workshop titled "Designing Roots". A total of 30 participants from universities, forestry organizations and construction companies took part. In the morning, the idea of "designing roots" was introduced using a photo database. In the afternoon, participants tried hands-on work using actual equipment.

Even in dry sand areas which are constantly moved by wind, if you dig 1-2 m below the surface you will find small amounts of moisture. This subterranean moisture is relatively stable regardless of seasonal fluctuations in ground surface moisture. Trees naturally growing in this type of area extend their roots to this deep moist layer. However, even a drought-resistant seed can only just manage to sustain its life with this amount of water. In order to grow, there are different root system at the 20-40 cm level which spread radially over distances of more than 10 m. These roots collect water efficiently from infrequent rain. In short, there is a division of labour: deep roots support life, and shallow roots play a role in growth. This is how trees in arid regions survive.

When planting trees artificially, the first task is to ensure survival of the plant by ensuring its roots reach the level characterized by stable moisture as soon as possible. We can leave considerations of growth to the parallel roots in the shallow level that collect natural seasonal precipitation. If possible, it is a good idea to water the plant from time to time. Anyway, the important thing is for roots to reach the deep layer as soon as possible. In this respect, how about growing long roots before planting? Fortunately, plant roots are highly adaptable. We have found out that it is possible to grow roots one or two meter in length, if we try.

The difficult bit is digging a hole sufficiently deep to plant such long roots. The ease with which sandy soil collapses makes the planting task even more difficult. However, even in these difficult circumstances there is a way to cope; namely by applying a device made from vacuum cleaners which employs two long tubes. The first fat tube, which covers the second thin tube, prevents the sandy soil from collapsing. The thin tube inside the fat tube vacuums sand out. The space between the two tubes acts as an air supply pipe. In early days of innovation, this device was only used in sandy soil, however, the technology has been improved and can now also be used in hard clay soil.

The basic idea for the technology was consolidated several years ago, and a number of experiments have been conducted in the Middle East, as a part of overseas assistance projects concerning arid agriculture and greening of the area. In May 1997, we held a workshop in cooperation with staff from the UAE's Afforestation Bureau which has been enthusiastically promoting plantation projects in desert areas. This was the basis of our workshop in July. A workshop is not just a one-way lecture. It is a gathering of people who interact with one another in order to find something new. We hope that this workshop does not end up with just one gathering, but will instead lead to the creation of networks among the participants that will help further examination and/or improvements in the field of root design. As a result, we hope that the idea of designing roots will spread in many directions to many people, leading to the improvement of afforestation technologies in arid areas, a reduction in labour and water use, and an increase in the number of self-standing trees.



**Digging device
made from a
vacuum
cleaner**



A scene from the workshop (in the afternoon)

Long-rooted and ordinarily-rooted saplings

Homepage “Root Design”

AAI and the NPO, Association SAHEL, have established a homepage titled ‘Root Design’, based on the experience of practical and sustainable tree plantation activities in the Middle East and the Sahel region. The concept of ‘Root Design’ was discussed in AAINews Vol. 12. This homepage contains more information gained afterwards as well.

From the 11th to 15th November, 2001 the sixth international root study symposium, “Roots: The Interface Between Plants and Mother Earth” was held at Nagoya International Conference Hall. On this occasion we took part in the poster presentation session and corporate exhibition where we presented the above homepage and exchanged information with root researchers from other countries.

Below is the summary of the homepage. Please have a look if you are interested.

Root Design for Practical and Sustainable Afforestation

- Our Trials and Findings in Arid Areas -

URL : <http://www.open-resource.org/rootdesign/> **Appropriate Agriculture International Co. Ltd. & Association Sahel (NPO)**

Part I : Living in arid lands

A living life in the arid land is described especially in relation with trees, not by statistical data but by our actual experience in the area.

Part II : Root design - the basic concept

Why and how roots can be designed, and what kinds of possibilities are expected from the root designing?



Part III : From seeds to seedlings

- living with trees in the nature -

A practical guide of root design and afforestation, which helps to learn the necessary steps through experience in the field.

Mini Series: Sequel to “Designing Roots”

Part 1: Progress after the Workshop

As we mentioned in AAI News Vol. 12, we organized a workshop titled “ Designing roots” in the summer of 1997. In the morning session of the workshop, we introduced the notion of “Designing roots” using a photographic database. In the afternoon we had a practical session using actual tools. The combination of theory and practice was very well received by a large number of participants. There were many requests by academic journals and TV programmes for contributions.

We introduced the idea of “Designing roots” and actual activities in arid regions in the journals and symposiums listed in the table below. In addition, recently, a book titled “Root Design: food and environment created by roots,” was published by Japanese publishing named Yokendou, and this includes a section called “Greening of desert and root system growth” which summarizes our activities. Furthermore, our activities were broadcasted to the world through NHK’s satellite broadcasting.

Journal/TV Programme etc	Timing	Summary
“Root Research” Issue 6, Vol.3 Japanese Society for Root Research	Sept. 1997	Introduced the idea of designing roots, with the theme “new approach for tree planting in arid land.”
“Journal of the Japanese Society of Revegetation Technology, Issue 23, Vol 1 Technology Materials	Sept. 1997	Introduced AAI activities in the UAE, with the theme of introducing water saving tree planting techniques in arid area using long root cultivation.
“Green Age” Spring 1998, Japanese Greenery Research and Development Centre	Jan. 1998	With the theme of root system of trees for planting and nursing techniques, introduced nursing and planting technologies for long root saplings.
The Japanese Society of Revegetation Technology: Research Summary	April, 1998	Introduced our activities regarding long root cultivation and dew pit irrigation at a “sustainable tree planting” research committee meeting
NHK BS 2: Japan This Week	May, 1999	With a variety of footage, introduced “Sahel-no-mori (Forest of Sahel)” activities in Mali and applications of long root cultivation techniques.
Forest Consultant No 80, Society of Forestry Technicians	Jan. 2000	Introduced tree planting techniques in arid areas, focusing on the reality of many areas with highly limited materials.
Homepage of “Designing Roots”	Oct. 2001	“Living in arid area”, “Basics of thinking”, “From seeds to nature” at http://www.open-resource.org/rootdesign/index.html
Poster exhibition at the 6th Symposium of the International Society of Root Research	Nov. 2001	Introduced our activities and achievements at the poster exhibition “Root: Dynamic Interface Between Plant and the Earth.”
Root Design: Food and Environment Created by Roots, Yokendou	Nov. 2003	Root design: food and environment created by roots

As shown above, we have been widely introducing the concept of “Designing roots” making the most of various opportunities, while continuing with activities that aim to devise practical applications of this concept. What has become clear through these activities is that with normal saplings, one can achieve the same effect as long-rooted saplings, as long as there are the right conditions for roots to grow. In other words, if one plants normal saplings in the soil which allows their roots to grow to a certain depth, the same results can be obtained as with long-root saplings. In addition, we now have the possibility of planting very young saplings. When nursing long-rooted saplings, germination stimulated seeds are planted in plastic pots and then small saplings are transplanted to pipe-shaped pots. Even small saplings can be directly planted, as long as the selection of the planting location, pre-planting treatment and post-planting management are adequate and one can expect quite a high rate of survival.

Since the workshop, we continued to learn a significant amount through nursing long-rooted saplings and developing planting techniques, applying the techniques to afforestation activities in the field and dissemination of the results, as well as through trials and errors. In this new series, we will introduce a number of experiences in the field in development and dissemination of appropriate technology following planting of long-root saplings. We will also investigate the possibilities of application for afforestation activities in degraded lands around the world.

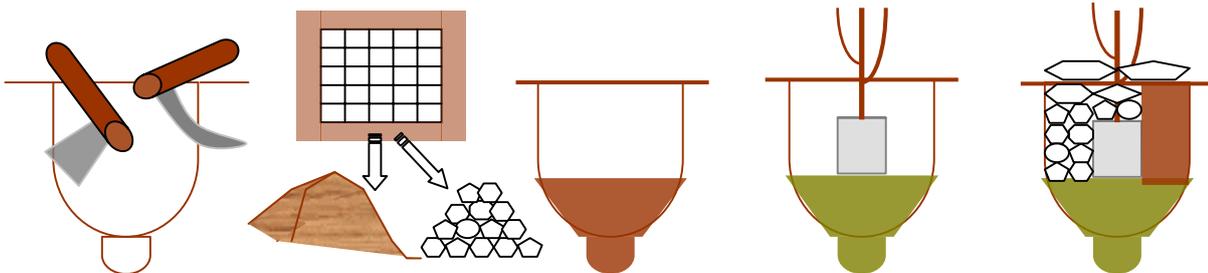
Mini Series: Sequel to “Designing Roots”

Part 2: Development of appropriate technology following long-root cultivation

In the northern edge of the desert in Sahel, there are deserts, dunes, stony plains and flat plains that are the remains of the bottom of dried lakes. Going a little further southward, one starts seeing farm land with crops that only require a small amount of annual rainfall, and seasonally used rangeland and woodland. However, many such farmlands and rangelands, which have been used repeatedly for millennia, are noticeably degraded having lost their topsoil. Tominian is in such an area. It is situated near the border with Burkina Faso and you can reach it from the Capital City Bamako, going on a major road to Mopti, leaving the Niger River at Ségou and go eastward through Bla and San. The NGO Saheru-no-Mori (Forest of Sahel) has been working in the town to restore natural vegetation and to promote afforestation and the greening of the area, making use of their experience with long-root cultivation.

The biggest success factor of long-root cultivation is how we can make roots reach permanently moist soil layers as quickly as possible. Once roots reach the layer, there is no need for watering and the plants will still keep growing. In Tominian, we are experimenting with the following method, attempting to attain similar effects as long roots, using ordinary saplings or young saplings.

- (1) Dig as deep a planting pit as possible using locally available tools
- (2) Divide the dug soil between fine soil and pebbles by sieving
- (3) Place fine soil mixed with livestock dung at the bottom of the hole
- (4) Pour ample amounts of water in the pit and plant the sapling
- (5) In order to ensure that water reaches the deep part of the pit, create vertical pebble layers and evaporation preventing mulch



By planting in this way, we can not only obtain the same growth efficiency as planting long root saplings, but also limited rain drops will be fed directly to the growth area of the root system without waste. In order to effectively trap rain water, it is important to observe detailed micro topographic conditions. Therefore, it is useful to mark areas that are even slightly lower than surrounding areas by walking around the planting area after rain. Sometimes there are no pebbles in soil dug from planting pits. It is important to identify places where pebbles and stones can be found. As we explained when we introduced the use of pebbles and stones in arid areas in AAI News Vol. 8, the use value of pebbles and stones for improving water permeability and mulching is very high. Rather than sticking to a particular technology, it is increasingly essential, in development assistance, to create processes to develop technologies appropriate for particular areas, by combining various technologies.



Digging a pit using locally available tools



Effective use of pebbles and stones



Sieving dug soil

Mini Series: Sequel to “Designing Roots”

Part 3: Extension Methods for Appropriate Techniques already developed

Previously, we developed long roots cultivation techniques and the use of stones in cultivation. At this next stage, it is now an important task to extend the techniques in the field. In the field, people have been repeating trials and errors to promote the techniques, and from these efforts we feel that we have been slowly learning what would be effective extension methods. We would like to introduce a taste of such methods.

Firstly, tree planting activities in Mali supported by the NGO “Sahel no Mori”. We suggested a “multiple site and stage model.” With this method, local residents themselves implement activities using techniques and materials appropriate to each site. They then increase the number of small sites. As a result, under extremely harsh conditions, they are avoiding or spreading risks of project failure between the different sites. The whole operation is small scale, with multiple sites, and is conducted by a small number of people. At some sites trees are one year old, and at other sites they are only 2 weeks old, which provides live information on the various growth stages of planted trees. We have learned that this is a very important motivating factor for local residents who may be interested in starting their own activity.

Secondly, when considering tree planting as an integral part of water basin conservation, the notion of resource management becomes extremely important. Generally, stones covering soil are seen as obstacles to agricultural development or tree planting. We would like to suggest ways to effectively utilize stones, considering them as important resources. In other words, under large stones or gaps between stones and soil, there is sometimes very fertile soil created by micro-organisms adapted to specific micro climatic conditions. Therefore, when one plants seedlings between stones, they do not only grow well, but are also protected from animals. Moreover, if one piles stones, they have water saving, soil erosion prevention effects, as well as wind breaking effects. As it is, in an effort to spread technologies, it is important to take into consideration micro topographical conditions and the utilization of obtainable materials as resources.

In tree planting activities in arid areas, considering the degree of soil moisture, it is normal practice to plant during the rainy season to prompt rooting of seedlings. In contrast there is also a move towards planting deliberately in dry season. The rationale is that if planting is done according to the soil moisture level during a dry season, making sure that the seedlings will survive through the season, it would be certain that the plants will grow well as the rainy season would come next. In addition, farmers are generally not as busy in dry seasons as they are in the rainy season. This provides another very good reason for planting trees in dry seasons. In fact, “Sahel no Mori” implements dry season planting in villages around Tomini in Mali. The good records of rooting and growth have been surprising villagers.

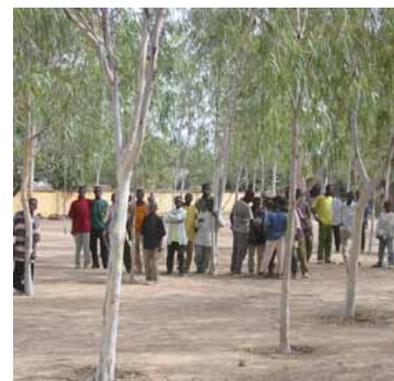
What is often done to promote technologies is to gather village representatives in a large town, explain techniques and the thinking behind them inside a conference facility, followed by a field visit. Here, we would like to suggest what one might call a field workshop method. With this method, technology promotion is done in villages, hence participants are villagers who are considering planting trees or who have planted trees. The main activities are actual work (digging holes, planting seedlings and building a protective fence etc.), rather than just sitting and listening to a lecture in a classroom. As these activities take place in an open space, children can also observe. By actually doing work in a village, one can also find enthusiastic villagers and children. In this way, it is expected that continued technical support can not only open a path to their economic stability but also promote higher skills and knowledge in villages by nurturing the next generation of leaders.



Tree planting in the dry season



Field workshop



Children surrounding and watching the workshop

Mini Series: Sequel to “Designing Roots”

Part 4: Future potential

Considering land use of arid and semi-arid areas, it is recommendable that areas with fertile soil and good water availability should be used for producing food that is in short supply. Degraded areas with little topsoil and shrubs are often chosen as candidate areas for tree planting. Generally, there is a lot of such degraded land in arid areas. If we can improve vegetation in these degraded areas, pressure on the existing vegetation that remains can be alleviated. Benefits that can be derived from these lands are then more likely to have the potential to be used sustainably. Therefore, we started thinking about how we could make use of the “roots design” experiences in an effort to develop economical tree planting methods suitable for such degraded land.

In arid regions, vast degraded areas are utilized for goat and sheep grazing dependent on very scanty vegetation. In order to plant trees, one normally cultivates seedlings in nurseries and the seedlings obviously need water. In addition, in the beginning, there need to be protective measures against animals as well as provision for watering. This necessitates procuring wells and wire netting and these considerations prevent tree planting from spreading widely. Therefore, we are experimenting with ways to plant trees in a way that uses the least work and money, without using nurseries, wire netting or wells. We tried providing a minimum of water to seeds for 2-3 weeks to help seedlings settle and root in the ground and used bricks and dry branches to protect them. With this method, it is necessary to manage the roots comprehensively both above and below the ground, making the best use of brief rainy seasons. In practice, we plant seedlings with many lateral roots in the dry season and by feeding water deep underground we nurture and consolidate these deep roots. In this way, seedlings are prepared for effective utilization of rain in the rainy season. It is also important to keep a good balance between leaves and the root system by cutting off some branches and leaves to reduce water loss through transpiration so that the seedlings can survive the dry season without additional watering. The philosophy “designing roots,” which started with nursing long-root seedlings, has been nurtured through a system of trial and has provided us with extremely important tips when it comes to planting trees in areas with bad conditions such as degraded lands.

Once vegetation increases in degraded lands and shows natural self-regeneration we haven’t just planted trees. We have “planted water”! Desertification can be considered as a situation where the amount of water that passes and stays underground becomes smaller both in the quantity of circulation between air and land surface, and in length of time of soil retention. It is considered that we can prevent desertification and restore degraded areas by increasing underground water retention and reticulation thereby slowing down the speed of water passing through the natural system. The objective of tree planting in this environment is not to generate income from forest products nor CO₂ absorption. It is for the use of people in their daily lives and making an improvement in the surrounding environment brought about by recovered vegetation. Given this, we believe that it is critical that trees are planted in a way local people can easily do without assistance. We would like to end this mini-series, with the hope that the concept of “designing roots” will be used effectively in areas facing desertification and land degradation, and that we will see an increased vegetation recovery in the future.

