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**AGRICULTURAL COMPETITIVENESS AND ENTERPRISE DEVELOPMENT  
PROJECT (ACED)**

# **STATUS ASSESSMENT AND STRATEGY FOR DEVELOPING GREENHOUSE FACILITIES**

**AUGUST 2011**

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## Summary:

Six goals were initially itemized along with 13 methods to achieve their accomplishment. Broadly speaking they were reduced to several aimed at improvement of greenhouse facilities, grower education, development of state agency/grower interaction and association development.

In order to substantially increase income, tomato harvesting must begin earlier in the spring and extend later into the fall as these are the periods of higher prices.

Under existing conditions most of the smaller greenhouses will have to be reconstructed. Only this will make them competitive both in the sense of extending tomato production as well as to be heated and cooled economically. Steel tube or pipe framed greenhouses should be designed and built locally as this would reduce the cost per square meter by over 50%. Similarly, heating systems designed to burn wood or straw should also be constructed locally.

Small tomato growers undoubtedly number close to a thousand or more. Development of a monthly newsletter would allow these growers to be “educationally” touched monthly at a reasonable cost. In addition, a Train-the-Trainer program is highly recommended.

Due to grower’s small size/production, development of a marketing association will be absolutely necessary if exporting is to be achieved. Developing an association whether for purchasing, education, marketing or whatever, requires a major shift in an individuals thinking and planning process. Individual control of crop pricing will be totally lost. Psychologically speaking, this topic should begin very soon but be presented in very small amounts in order to help growers begin thinking about all of the ramifications. Again, a newsletter would be ideal to start the process.

Although there are some large and mid-sized growers in the country, the small, few thousand square meter growers are huge by comparison. For this reason, most of the following recommendations are directed primarily toward this latter group.

### STRATEGY GOALS:

- Extend production and marketing season in spring and fall
- Increase total income
- Increase marketable output (crop quality)
- Lower costs
- Information dissemination
- Develop marketing cooperatives/associations

### IMPLIMENTATION GOALS:

- Improve greenhouse design
- Extend production periods of spring and fall through environmental control
- Improve crop quality and quantity, particularly during critical spring and fall
- Improve varietal selection

- Reduce heating costs
- Reduce polyethylene loss during severe weather
- Reduce all production and maintenance costs.
- Improve labor savings devices thus reducing labor
- Develop and present production and management training
- Develop low cost information dissemination , i.e. newsletter, demonstrations
- Improve relations with allied business, i.e. chemical/fertilizer dealers
- Improve relationships with all government systems, i.e. ACSA, Dept. of Agriculture...Horticulture
- Begin development of associations

#### **CURRENT SITUATION:**

Approximately 10 days were spent visiting vegetable growers, their greenhouse facilities, farming and greenhouse support companies such as greenhouse, plastic and chemical supplier, various agencies (Dept of Agriculture), ACSA (extension service) and others.

Several major reports were reviewed in order to gain a basic understanding of the greenhouse vegetable industry and its respective strengths and weaknesses.

- Protected Cultivation of Vegetables in Moldova (census report), 2009
- Using Alternative Sources of Energy for Greenhouse Vegetable Production, Compendium of the Second National Forum of the Cluster “Producing Vegetables in Protected Spaces, March 29, 2007,
- Climate Change and Agriculture, Country Note, November 2010

The author has also viewed many similar situations in at least 9 countries of the previous Soviet Union plus many more in other parts of the world.

Moldova is located from 45 to 48 degrees N latitude which is similar to the area from Salem, OR to Seattle, WA or the northern edge of New York State to about 200 miles into Canada. Weather in the southern part of the country is modified somewhat by it’s proximity to the Black Sea being slightly dryer and warmer than the northern areas.

Many field crops rely on summer rain and are therefore subject to loss during exceptional dry years. Two major rivers constitute much of the Eastern border with Ukraine (Nistru) and the Western border with Romania (Prut). These and several other smaller rivers are used for both field and greenhouse irrigation. Wells are preferred for greenhouse irrigation because of a lack of disease and weed seed as found in river water.

Tank trucks are sometimes required since some wells do not produce sufficient for there needs. Growers in at least one area near the Romanian border are plagued with unusable salt water wells. Although some major irrigation projects developed during the Soviet time have been restored, irrigation in this “salty” area has not been reclaimed.

Summers can be quite hot (to 40C) and winters quite cold (to -20C), however, these are extremes.

Adequate sunlight is available most of the year for greenhouse crops. Light intensity is quite low during December and January and the photoperiod is less than 8 hours during this period.. The open winters allow crops such as tomatoes to be harvested late in the fall and new crops started in late December or early January for spring harvesting.

Most of the country is blessed with excellent soils. These are similar to the black soils of the Russian steppes. Both structure and texture are excellent for crop growth; generally they have excellent drainage, good Cation Exchange Capacity (CEC), moderate pH and a wide array of natural nutrition. In addition to the natural qualities, farmers use large amounts of cattle manure which helps maintain soil quality. During my visit, I found no nutrient deficiencies which is almost unheard of for such a large area!

A wide variety of greenhouse structures were visited and many others viewed while traveling. Most are of very poor quality; extremely low eaves and roof lines and not conducive to tomato or cucumber cultivation.

Covers are primarily single layer greenhouse grade polyethylene with a normal life of 3-6 years depending on manufacturer, weather conditions and accuracy of application. A few very old glass covered buildings are still used but the vast majority are polyethylene covered. Only a few growers are using or considering the use of double layered, air supported polyethylene covers.

Most greenhouses as used by small growers are about 2 meters at the eave and are low profile Quonset shape without any roof ventilation. Sides are normally made so that they can be rolled up but again, these openings are not large. Crops are normally grown in rows running lengthwise of the buildings.

Heating systems are generally very poor. Most burn wood or straw which is by far the cheapest fuel, however, these systems require a great amount of labor and are generally only as reliable as the persons ability to stay up all night. Heat is usually distributed either as warm air or hot water. Hot water distribution is much more accurate in heating entire buildings and preventing cold spots in corners, etc.

## **Recomendations:**

### **I. GREENHOUSE DESIGN AND CONSTRUCTION:**

Ventilation: Influences pollination, crop quality and quantity, reduces production and maintenance costs, reduces labor.

Most current greenhouses are very low thus creating major problems in ventilation, overheating and the opportunity to include overhead shading systems for summer use and/or thermal screens for heat conservation in winter. Buildings should be a minimum of 3 meters at the eaves. Some western companies use 4+ meter eaves. Most of the following recommendations are listed in order to develop a "chimney effect", thus reducing inside temperatures.

- Regardless of roof shape, roof ventilators that run the full length of the building must be included in new construction. Rollup sides must always be included. When continuous roof vents are used, it becomes much easier to replace either single or double polyethylene covers. Both roof and side ventilators can be operated manually or motor driven.
- Tall crops (tomato, cucumber) should be planted across the house instead of the traditional lengthwise direction. When done in this manner, cool air can enter the sides and not be blocked by a heavy green wall. In short, all of the above recommendations will allow a chimney effect to be developed and natural cooling will occur.
- Planting across the house as opposed to lengthwise greatly improves labor efficiency. Buckets or boxes filled with ripened fruit are carried the length of the building during harvesting. Short rows allow a single wide aisle be developed thus allowing the use of a cart to move harvested fruit. One person can easily move 50-80 kg at one time instead of 10 kg in boxes. If laid out properly, plant numbers will remain the same or be greater than planting lengthwise.
- It is hoped that subsidies offered by the state for construction of new greenhouses will take into consideration the above recommendations. Builders of traditional greenhouses should not receive any subsidy.

Greenhouse Covers: Reduces general and maintenance costs, reduces labor, increases heating efficiency.

Three conditions are very detrimental to the longevity of polyethylene. These are ultraviolet (uv) radiation from the sun. This problem is reduced by always using "greenhouse grade" polyethylene from reputable dealers which contain a uv inhibitor. Second, when not anchored properly, high wind velocity will destroy polyethylene through continuous shaking and pulling. Lastly, heat is a major problem. When sunshine strikes a dark object such as a dark board or unpainted pipe, the natural wavelengths turn into infra-red (ir) radiation or heat energy and in time easily destroys plastic. This effect can sometimes cause plastic to fail in only one year.

- Always paint any surface that is directly exposed to the sun with white latex paint...do not use oil base paint.
- If plastic is already in place, the plastic (about 10 cm wide) directly over the dark object.
- Where heating will be used in spring and/or fall, use double layer, air supported construction as this can reduce heating costs in excess of 25%. Maintain air pressure between the two sheets at about ¼ inch or 1 cm of static water pressure.
- Horizontally placed thermal screens can be added to houses where head room is sufficient. Although very expensive screens are available on the world market, it is recommended that growers build their own and for the first few years use 100 micron polyethylene film. These

are used at night during winter months to conserve heat and in summer to slightly reduce sun intensity and thus reduce overheating. These screens are made to slide horizontally over the crop and then be returned to the edge of the greenhouse when not in use. See information in the appendix.

- In addition, some growers have also made similar screens for house sides.
- North facing greenhouse walls allow only very little light to enter the building. For this reason, north walls are often made of wood or covered on the inside with aluminum foil to reflect light back on to the crop.

Heating: Reduce production costs, reduce labor.

It is assumed that most growers will continue to use baled straw or wood as their primary heating fuel. Large capacity systems purchased in Western Europe appear to be extremely expensive when advantages are compared. It is assumed that a local steel fabricator could build these with little problem.

- One large unit had a hot water storage of 41 tons. In short, a tremendous amount of fuel is required just to heat the storage system prior to moving any of the heated water into the greenhouses. Smaller storage coupled with more heating lines and/or higher volume pumps could better support the system.
- If hot air systems are used, these should be coupled with a long perforated polyethylene tube connected to a fan placed near the heat source. Warm air can be delivered throughout the length of the building. These tubes are often 30 cm in diameter and made out of thin polyethylene (100 micron or less). Holes of about 8 cm diameter are cut in the side of the tube at approximately 30-40 cm intervals. These distribution tubes are usually run overhead the length of the building.
- Growers using hot water regardless of its source, should not use gravity fed systems. These move water very slowly. Thermostatically controlled pumps should be used to move heated water rapidly through the piping system.
- Finally, the combination of a more effective and labor efficient burner with the use of air supported double polyethylene and overhead thermal curtains should greatly improve a grower's ability to lengthen the growing season and produce more fruit during high price periods in spring and fall.

Irrigation and Fertilization: Increase crop quality (flavor) and quantity, Reduce labor, Reduce total water use.

Most growers are currently using drip irrigation. This should continue to be promoted along with the use of mini-sprinklers particularly when growing vegetables in bed culture as opposed to row culture.



- In vegetable bed culture, mini-sprinklers cost less, use far less water and do a much better job of distribution than drip systems. Bed culture will produce far more product than row culture of items such as pearl onions, radish, leaf and bib lettuce, radish, parsley, etc.
- Promote the use of water-soluble fertilizers to be used in conjunction with manures and other organic waste products. These will be particularly effective in short term bed culture as mentioned above, In addition, it is well known that higher potassium levels during the ripening phase in tomatoes will greatly enhance flavor. Where 100-150 mg/l of potash is used in irrigation water during the early stages of tomato production, 300-350 mg/l is used during late stages and ripening.

## II. THE TOMATO:

Pollination: Improves fruit size, quality and quantity.

In nature, pollination of tomatoes is accomplished by wind and insects including bumble bees. Bumble bees are pollen collectors and do a very good job. Honey Bees on the other hand, gather nectar. They quickly learn to ignore tomato flowers since they produce almost no nectar.

Following normal pollination, the pollen grain germinates somewhat like a seed, and travels through the stigmatic tissue, finds an egg cell and fertilizes it. This develops into the new seed. As seeds develop they give off hormones that cause the flesh of the fruit to grow. If pollination does not occur the flower drops off and no fruit is produced. In tomato, small amounts of pollination results in only a few seed developing and only a small fruit develops.

Traditionally, growers have used some type of flower vibration to insure adequate pollination. This can be done using a commercially made vibrator. Many other systems have been tried with little success, i.e., air blasts from leaf blowers, sonic booms, shaking support wires, etc. Commercially produced Bumble Bees and flower vibration are most effective.

Nearly all growers in Moldova use a hormone spray to begin development of fruit. Use of CPA bypasses normal pollination and a fruit is produced. CPA (4 Chlorophenoxy acetic acid) is the most commonly used product. Since much of the juice in the tomato fruit forms around seeds, CPA fruit are often very hard and rather dry. These are preferred by the marketing and shipping industry because they are easily mechanically handled with little or no injury.

- Spraying is best done to the backs of flowers when 3-5 flowers are open and temperature is less than 30C. As with most chemicals and hormones, spray applicators should use rubber or latex gloves and keep the material off of their hands and arms. Any single flower truss (group of flowers) should be sprayed only once.
- Spaying of field grown crops is not recommended as leaf and stem distortion often occurs.
- It is the opinion of the author that both methods should be used in order to obtain the largest and most acceptable fruit.
- Since much is said throughout the world regarding the restriction of chemicals, it is absolutely necessary that growers be aware of the whole picture of pollination, seed growth and fruit development. If use of this chemical was cancelled, growers would then know how to continue without a break in their production cycle.

### III. GROWER TRAINING:

It is recommended that several training systems be established. Since there is a large number of potential clients, it is recommended that a monthly newsletter be developed.

The following items are suggested:

- Use a piece of paper equal to two sheets of A4.
- Have a printing company do the printing and folding.
- Fold the double A4 to a single A4 size and then either fold in half or into thirds
- When names and addresses are collected, make sure that they are stored in a format that the printing company can access. They can print names and address or add address labels at the time of printing.
- Check with the postal service to see if postage can be printed directly on the folder.
- The first half or one-third of the first page is for company name, clients name and address.
- Keep articles short and to the point. Print at least 7-8 articles monthly.
- Possible topics: meeting locations/topics, pesticides, fertilizers, greenhouse topics, irrigation, other groups are likely to ask if their meetings can be included, current information on imports, prices, etc.
- At years end, add a Table of Contents listing all of the year' articles.
- Suggest that growers keep the newsletters for later reference.
- If new products come on the market, ask the company to supply a "short" message concerning the product. Take care not to accept "glowing" recommendations ....keep it straight forward...product name, and here is what it does!

Similar training can also be put on the internet with only a few clicks.

It is recommended that a "train-the-trainer" system be developed and that the following items be combined into several comprehensive training sessions. Make the training session long enough to justify driving the distance to the meeting place. At least 5 hours per session is recommended. When handout materials are suggested, make sure that each meeting location (trainer) has exactly the same materials and enough handouts so that all trainings are as uniform as possible. Quiz trainers so as to determine that each agree with the accuracy of the training materials. If trainers begin teaching different opinions, the results could cause a total failure of the program.

- Construction materials, pipe vs. wood, wood strips vs. locking devices for polyethylene, types of paint, etc. manual vs. automated controls
- Soil cover fabrics...ground cloth
- Greenhouse covers: polyethylene, poly carbonate, glass and others.
- Shading materials for use on the outside of the greenhouse
- Interior shading and thermal blanket systems
- Factors affecting cover life and how to extend cover life
- Ventilation: beneficial as well as harmful effects
- Heating: types of heaters and their controls
- Fuel: wood, straw, oil, gas, etc. and their controls
- Problems associated with specific fuels and flu gasses
- Soil: types, structure, texture, modifying,

- Artificial soil mixes
- Fertilizer: soluble, insoluble, slow-release
- Basic fertilizer rates: soil, foliar sprays, major, secondary and minor elements
- Rate calculations: kg/hectare, parts per million, mg/l, etc.
- Organic wastes – manure, straw, etc. Selecting the proper material for the job
- How plants grow, photosynthesis and respiration.
- Fertilizer injection
- Modified hydroponic fertilization
- Irrigation: drip, furrow, sub-irrigation, sprinkler, mini-sprinklers
- Water quality – salts, EC, wanted as well as unwanted elements
- Water sources: rivers/streams, holding ponds, wells, springs
- Water storage problems: algae, bacteria
- Plant food is light...it doesn't come in a bag
- Basic crop growth, photosynthesis and storage
- Environmental control
- Basic temperature effects, too high, too low
- Effects of high or low light intensity
- Influence of day/night length on specific crops
- Combining environmental influences
- Flowering vs. vegetative growth and it's control
- Flowering and flower parts
- Pollination and its role in seed and fruit production as well as flower longevity, mechanical, bees, hormone (4-CPA) 4- chloro-phenoxy acetic acid
- Fruit production, incompatibilities, other problems
- Production of specific crops: tomato, cucumber, greens, roots, etc.
- Insect pest development
- Insect and spider mite control
- Factors that promote fungi and bacterial problems
- Diseases and their role in crops production, identification
- Disease prevention and control, humidity
- Nematode identification and control
- Pesticides and the influence of water pH and time
- Spray application and equipment for greenhouse use
- Pesticide safety, container recycling or disposal
- When all else fails, modified hydroponics – modified container media – containers
- Harvesting, grading stages,
- Small Styrofoam cold storage facilities
- Cold storage temperatures, length of storage life,
- Packaging or alternatives

#### **IV. ASSOCIATION DEVELOPMENT:**

Among small growers, no one family is usually large enough to sell to a large grocery store or grocery chain. Therefore, the only way to move ahead is to come together and form associations or cooperatives. Individuals will be required to “give up” many business freedoms as well as be ready to accept grading results done by a third party. Often, association members are required to allow the association to market a specific percentage of their total production. If the farmer sees a chance to sell for a greater price, they will find that for the association to work correctly, they must put the needs of the association first!

Associations can function positively in purchasing, selling, advertising, legal matters, legislation, training and a number of other areas. Associations don't have to be large, just effective and have a great management team. Members of the association function as directors, committee members, etc.

Since it is essential that only highly uniform crops leave the grading site, members must have total confidence in the grading system and be ready to accept the grading percentages as determined by in-house and market standards. This is probably the most difficult aspect since everyone knows “they” raise the highest quality among all the growers. Secondly, when a grower commits a specific percentage of their crop to the association, they can't sell it elsewhere even though they might find a better price. The association must come first!

- Since starting an association means major psychological as well as monetary changes/risks for a farmer, it is highly recommended that this type of marketing be discussed briefly at every meeting. This will give the farmer “time” to discuss it with family and other potential members prior to coming to the point of voting to move ahead. In short, the grower will lose control of pricing, etc.....a change that many may not choose to do.

#### **V. MARKETING:**

Marketing involves many entities, i.e. growers, associations, many segments of government such as Customs, Transportation, Agriculture, Taxation, etc. Growers must work together to have a sufficiently large product volume for a foreign company to be interested.

Marketing doesn't have to include many different hands in the system. Flower growers many years ago, cut out many of these “hands” and large users of flowers such as large florists, grocery stores, etc. purchase direct from growers, many of whom are located in different countries.

Since markets want a year around source as well as a very uniform product, associations where many growers use all means possible to lengthen their production season are generally in a good position to compete for business.

## VI. GOVERNMENT:

Some tasks can only be promoted by government or other state agencies. Some of the following have been reported here and some from other countries who face similar problems.

- Continue to evaluate crop varieties. It is suggested that DAI contact 4 or 5 of the largest vegetable seed companies and ask for samples to be used in a vegetable trial that will be conducted at several locations throughout the country. See appendix for a sample letter.
- It is highly recommended that information be obtained from suppliers and ask the Department of Agriculture or Horticulture section to evaluate products that don't appear to be correctly labeled. For example, many growers believe that some hybrid seeds are being replaced by varieties of lower quality. Similar occurrences have been noted when fertilizers are diluted with sand or other products prior to sale. The farmer has enough problems without having to worry that his 20% nitrogen fertilizer may only contain 5% nitrogen.
- It is sometimes found that some agricultural chemicals and fertilizers have been diluted by suppliers prior to sale. This has been a major problem in some countries and can only be corrected and prevent by government. In my state, products such as these are periodically tested, violators are fined, may lose their business license and their names and fines are posted monthly in an industry newsletter.
- Work directly with ACSA and the Dept. of Agriculture in evaluation of market worthy varieties as these may differ in different parts of the country as well as for export.
- The Horticulture Division of the Department of Agriculture has monthly information regarding what and how much of a crop is being imported. This information should be in the grower's hands and should be used to select other optional crops so that a bite can be taken out of imports. Excellent item for a newsletter.
- Growers should help keep regulation to a minimum. Every regulation limits ones ability to function.
- Formation of grower cooperatives or associations should be greatly promoted. As more growers work together, they will find that government will come to them for their advice and approval regarding new regulation, etc. One grower, one vote, ....one association, 100's of votes....Where do you stand?

## VII. SUBSIDIARY BUSINESS:

Greenhouse Builders: Local steel fabrication shops should be investigated in order to find someone who is interested in building greenhouses to very specific specifications.

- See appendices for diagrams, etc. on suggested styles of buildings etc.
- See also appendix for web sites with prices, pictures, etc for comparison. [www:hpp](http://www.hpp.org) Oregon Valley Greenhouses, Inc., and Ohio State University Fact Sheet: AEX-802-00 (Overhead thermal screens, condensation control, etc.)

Heating System Builders: As mentioned above, heating systems should be constructed locally. Moldova has the tools, metals and the technical people to do the job.

Recyclers: The recycling industry world-wide continues to put themselves in positions to “help” cities reduce their costs. This is done by removal of large portions of Metropolitan Solid Waste (MSW), in short...garbage. Recyclers remove and sell, metal, glass, plastics, paper and other items so that the waste going to landfills is greatly reduce.

Other recyclers show cities how much of the remaining garbage can be composted and made useful to agriculture. If done properly, the final product can be directly applied to agricultural fields. However, many companies do a poor job of garbage separation prior to composting. Farmers don’t need broken glass and chips of plastic spread in their fields. If done properly, the final composted product will be very useful and be almost totally free of glass and other sharp articles.

To make sure these projects are done correctly, Agriculture can become “friends” with cities and become involved prior to the cities writing contracts that they later regret. If done properly, cities will do many things to make life easier for the farms. These may include improvements to sales markets, locally or municipally owned cold storage for such markets, road and sales area maintenance etc.

Agriculture is well positioned to incorporate composted city waste into fields which often reduces the need for manures and other fertilizers. Sewage sludge is often separated, composted, dried and again used in specific ways that are not detrimental to crops or the public. This results in happy city administrators as well as the general public. Most cities that are not using these processes have rivers that no one wants to swim in, don’t want to eat their fish or use for irrigation water.

In another scenario, agriculture uses and disposes of hundreds of hectares of polyethylene film each year. The greenhouse industry in my area recycles this material and sells it to China. They in turn make toys, boards, etc.

The bottom line is that agriculture often becomes a dirty word to “city dwellers” and slowly is looked upon as a not so necessary industry. Working directly with city governments can not only be directly profitable to the industry but also maintain great relations and eliminate hurtful political restrictions. It all comes down to being proactive and not waiting until it’s too late.

## ***APPENDIX 1: Pipe***

Pipe sizes: Inches and mm equivalent (mm are outside and inside dimensions)

½ .....22/16 mm

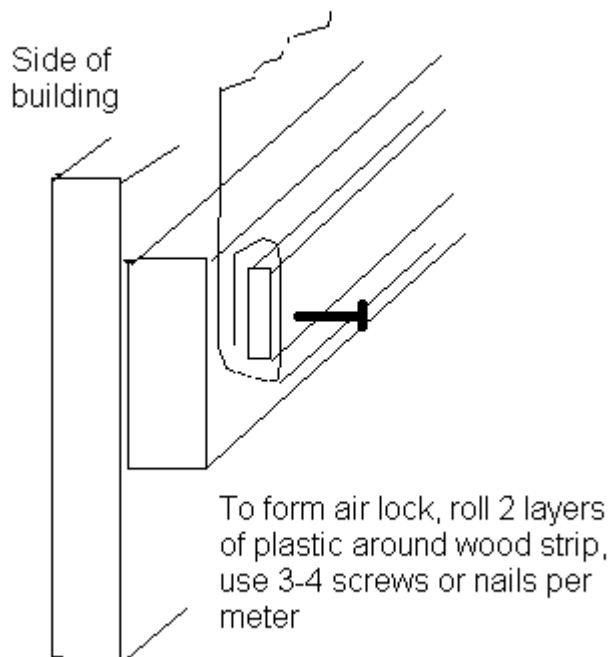
¾.....27/21

1.....34/27

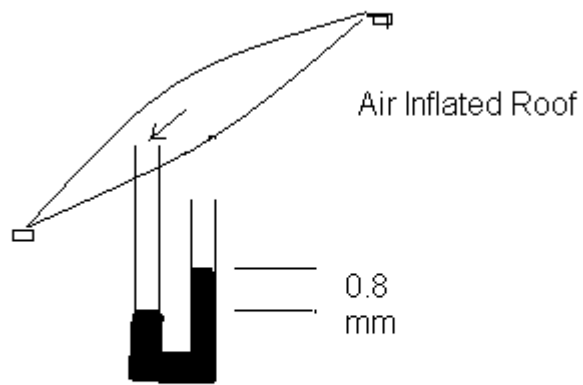
1-1/4..43/35

1-1/2..49/43

2.....61/53







Air pressure changes length of water column. Adjust to 0.8 mm difference.

