



Deliverable: 4.2.4

Farming guides and technical solutions

PART A: Technical solutions and equipment guide

PROJECT: Social agri-entrepreneurship for people with disabilities in the crossborder area

AGRI-ABILITY

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Preface

The report entitled “Technical solutions and equipment guide” is the first part of the Deliverable 4.2.4 Farming guides and technical solutions, of the Democritus University of Thrace within the framework of the project “Social agri-entrepreneurship for people with disabilities in the crossborder area” (SC: B2.9c.09-AGRI-ABILITY) implemented under the framework of INTERREG V-A Greece-Bulgaria 2014-2020 Cooperation Programme. The report was designed to promote understanding of the current situation regarding technical solutions and tools that may be used to assist people with disabilities in performing tasks relevant to agriculture and gardening. The report and material presented is strictly for educational purposes. The list of technical solutions and tools represented herein is not by any means exhaustive, since several types of equipment are released every year, thus references to products in this manual are not intended as endorsements to the exclusion of others which may be similar. The guide aims to disseminate knowhow, raise awareness, inspire and encourage people with disabilities towards their social and economic activation in the agricultural sector. The authors assume no liability in connection with any use of the products presented and make no warranty (express or implied) in that respect; nor can it be assumed that all safety measures are indicated herein or that additional measures may be required. The user, therefore, must assume full responsibility, both as to persons and as to property, for the use of these materials including any which might be covered by patent.

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1. Introduction

As society, especially in rural communities, becomes increasingly inclusive and access to technology becomes more affordable and reliable, the uniqueness of seeing a person with a severe disability working in agricultural production will likely disappear. Vigorous, labor intensive-tasks that a few years ago required two strong arms and legs and a strong back are being rapidly taken over by highly automated machines or replaced entirely by changing agricultural practices (Field and Jones 2006).

An individual's ability to access land (natural capital), microcredit (financial capital), machinery, tools and equipment (physical capital), labor (human capital) and the ability to leverage on relationships and networks to be able to carry out agricultural activities (social capital) determines his or her participation in agricultural production. Thus, levels of access to the different capital assets will interact to determine an individual's ability to productively engage in agriculture and this will have implications on their household food security situation (Gomda et al. 2018).

Assistive devices and technologies are those whose primary purpose is to maintain or improve an individual's functioning and independence to facilitate participation and to enhance overall well-being. They can also help prevent impairments and secondary health conditions. Assistive technology (AT) is the bridge that can help those farmers and ranchers who have disabilities or primary injuries to continue to be productive while reducing opportunities for secondary injuries. Assistive technology can focus on the needs of farmers involved in highly mechanized operations that require modifications. Assistive devices would enable them to continue operating equipment such as tractors, combines, and other self-propelled farm equipment. For example, if a farmer has lower extremity impairment and wants to drive a tractor, he would need is a tractor with hydrostat transmission that would not require much use of clutch or brakes. Resources designed specifically for farmers have been developed and widely distributed that address specific disability types, such as upper and lower limb amputations, visual and hearing impairments, arthritis,

and spinal cord injuries. It is not always necessary to purchase or fabricate specialised assistive technology. With a careful assessment of existing resources on many farms, possible solutions could be readily available. A farmer who develops mobility impairment could use an existing golf cart to increase access to remote areas of the farm (Khetarpal 2013).

Recent studies indicated that small farmers demonstrated an understanding of basic body mechanics, but showed inconsistencies with the implementation of this knowledge while a considerable number expressed a lack of awareness of assistive technology, but reported utilizing personal protective equipment (Behrens 2014).

In this perspective it is really important, as proposed by the WHO global disability action plan 2014-2021 (2015), to make known and available appropriate assistive technologies for people that are involved or interested to be involved in activities related to the agricultural sector (crop production, gardening etc) either as professionals or hobbyists.

2. Assistive technology (AT) in agriculture

Persons with disabilities that are involved in agricultural production often need to fabricate or modify devices and worksites. In this perspective Assistive Technology (AT) is any item or practice modified or customized, that is used to enhance functional capabilities of individuals with disabilities, in order to continue performing required tasks (Mathew et al. 2009). Assistive technologies are evolving quickly and include any item, piece of equipment or product, whether it is acquired commercially, modified or customized, that is used to increase, maintain or improve the functional capabilities of individuals with disability. Assistive technologies include low vision devices, hearing aids, augmentative and alternative communication, walking frames, wheelchairs, and prostheses such as artificial legs. The field also covers information and communications technologies such as computers, screen-reading software and customized telephones. Assistive technologies play a significant role in enabling people with disability to function and participate (WHO 2015).

In simple terms, any technology that helps an individual with a disability to carry out a functional activity is defined as assistive technology. Assistive technologies are primarily used to improve functional outcomes for persons with disabilities. A broad range of devices, services, strategies, and practices are designed to accomplish this overall goal. An AT system may involve the use of commercially available or custom-made, low- or hightech devices. Farmers and ranchers with disabilities have been using ATs to enable them to carry out different farming-related activities for many years. These technologies can be grouped into two categories (Grisso et al. 2014) :

- 🌀 Common to all operations,
- 🌀 Specific to the type of operation.

For example, a wheelchair used by a disabled farmer for mobility is a common AT, used irrespective of the type of operation. An AT used on a tractor to meet the special needs of a disabled operator will also fall in the first category. Characteristic examples of both categories are presented in the following sections.

2.1 Operation-Independent ATs

Tractor Alterations

Numerous examples of AT applications and associated tractor alterations exist to accommodate the needs of disabled farmers. The following figures present some common AT applications in tractors (Grisso et al. 2014).



Retrofitting tractors with additional steps



Tractors with handholds for individuals with difficulty in balancing, an irregular gait, a weak lower body, and/or arthritis.



Hand-operated mechanical linkage system for controlling the clutch.



Quick connect adaptor for attaching and detaching implements to the drawbar.

Living Space Alterations

Living space is often modified using appropriate ATs to protect farmers with disabilities from secondary injuries. These modifications may include major or minor interventions and solutions such as:

- ✓ Adding ramps for wheelchair access,
- ✓ Improvement of lighting in areas frequented by individuals with disabilities,
- ✓ Replacement of doorknobs with lever handles for a better grip.
- ✓ Use of manual or powered wheelchairs for mobility.
- ✓ Rubberized, nonslip surfaces for heavily used concrete floor areas.
- ✓ Corrective or improved footwear for back and arch support.

- ✓ Large zippers or snaps on clothing to help get clothing on and off.



Ramp for improving wheelchair access (Photo: Habitat Cabarrus)

2.2 Operation-Specific ATs

In terms of operation specific ATs, characteristic interventions may be classified according to the type of activity and may include (Grisso et al. 2014):

Horticulture, gardening and crop production

- ✓ Elevated garden for wheelchair users or those with other mobility impairments.
- ✓ Automatic grain-level indicator for grain bins
- ✓ Extended-reach shears.
- ✓ Garden bench for users.
- ✓ Long-handled bulb planters.
- ✓ Vertical gardening for individuals in wheelchairs.

Livestock and Poultry

- ✓ Easy-to-open spring-loaded latches.
- ✓ Quick gate latch for one-handed use.
- ✓ Small or large animal tip chute.
- ✓ Crutching frame with chest belt for sheep shearing.
- ✓ Deck chair to hold sheep while being trimmed, examined, or medicated.
- ✓ Pig holders able to hold pigs on their backs.
- ✓ Automatic feeders and/or motorized feed carts.
- ✓ Bale feeder for dispensing hay.
- ✓ Animal drinker that dispenses water each time an animal nears bowl.
- ✓ Base-heated water trough to reduce freezing.
- ✓ Feather picker
- ✓ Laying nest

3. Accessible farming and gardening tools/equipment

Factors such as advancing years, disabilities and poor health through accident or illness can limit what an individual can do in the garden and the agricultural sector in general. However, in most cases, it is possible to still enjoy agricultural activities and gardening. A wealth of information is available on designing and adapting the garden, specialist tools and equipment. One of the most complete source of information is the toolbox assistive technology database of Breaking New Ground Resource Center, Purdue University (Agrability 2019), from which several examples have been used. In the following chapters selected tools and accessories are presented based on the category of use.

3.1 Farming tools and accessories



The image is a composite of two photographs. The top photograph shows a field of green plants with a black sensor device labeled 'AgPee' and a clear plastic container with a white lid. The bottom photograph shows a laptop and a smartphone displaying the 'FIELDNET' software interface. The laptop screen shows a map with various colored zones and data points, while the smartphone shows a similar interface with a circular gauge and text.

Automated Irrigation Systems use data acquisition and control devices designed to monitor and control remote equipment sensors. Featuring wireless valves and field sensors, these systems are designed to allow one to program then monitor a crop's critical growing processes by use of operator selected set points (including such aspects as soil moisture and tension, pH, temperature and other atmospheric conditions). Some systems may notify the producer via cell, e-mail, or text message. By selecting the appropriate field zones, the producer inputs the desired irrigation times for the pump to start and right valves to open for timed input. Fertilizer injection system can be included if needed.



The Soil Probe Extension Handle allows one to take core samples without having to climb off his/her four-wheeler in loose soils or use the step plate in compacted soils.



Vacuum Powered Soil Sampler
The vehicle-mounted, hydraulically operated Speedy Soil Sampler allows one to take more samples in less time, even from frozen ground. The hydraulic system supplies power to the unit's outrigger, which lowers the sampler to the ground. The powered head moves the soil auger down the column to the desired depth. With the companion Vacuum Collection System (VCS) attached, the rotating auger conveys the sample into a collection cylinder at the outrigger foot, where it's transported by air to the system's vacuum chamber and deposited into one of four sample containers on a carousel.



The PenFriend Voice Labeling System consists of a digital pen and labels containing barcodes that can be "read" by the pen, which has built-in memory and a microphone/speaker system. This allows those with visual and hearing impairment to affix a self-adhesive label then scan it with the pen and make an audio recording of what that particular label represents. Touch with the pen any recorded label, and the message will be played back.



Plant Stress Detection Glasses Developed by NASA to identify plant stress or disease 2-10 days before it's visible to the naked eye, so there's time to react. The special lenses block out the green reflected by the chlorophyll in healthy vegetation, causing them to look black or gray. Any off-colors caused by drought, disease, poor nutrition, or other harmful conditions stand out against this dark background.



Bulk Seed/Fertilizer Tender, Caddy, or Wagon usually has a hydraulically powered auger with a long spout to transfer the material directly to the planting unit. Gravity-bed wagons, which may or may not have such augers, are used primarily just for seed transport.



Pneumatic-powered Planter Seed-Box Lid Lifters are designed to expedite filling or seed level checking tasks by allowing all the row-unit lids to be opened simultaneously with the turn of a knob. Each lifter's latching mechanism locks the lid down until released to prevent losing the lid during transport and planting.



ATV/UTV Big Bale Movers
With these single-spear, winch-and-pulley, two-wheeled ATV/UTV Big Bale Movers, one can reportedly load/transport/unload large bales without having to leave the driver's seat.



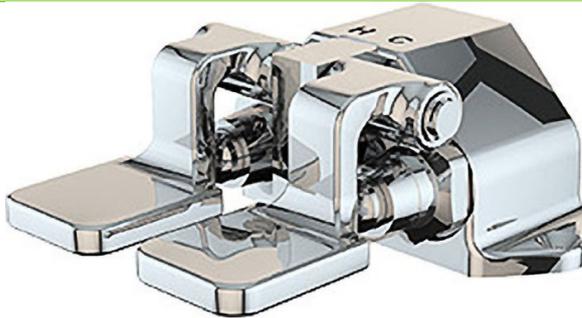
With the Rennie Belted Bale Wagon, a single operator from his tractor seat can reportedly pick up ten 4-foot-wide or twelve 5-foot-wide plastic- or twine-wrapped big round hay bales in about 10 minutes time then unload them in about 5 minutes.



Drum dolly is a round platform with caster wheels on the bottom. Available in various sizes, the dolly allows drums to be easily moved around the farmstead.



The hydraulically powered Forklift-Mounted Drum Gripper, which slips onto the machine's forks, allows one to lift and transport 30- and 55-gallon steel barrels via the operator's station controls



With a floor-mounted Foot Pedal Faucet Valve, one is able to control the flow of liquids (e.g., hot and cold water, liquid chemical and water, two different chemicals) solely by applying foot pressure.



Add-on Handles, which are affixed by bolts or clamps partway down the handle, maximize one's lifting ability and minimize the need to bend/stoop over as well as improve lateral control when using the tool.



The Kombi Serrated Garden Shovel is a wedge-shaped shovel with serrated cutting edges on each side of the blade. It can be used to cultivate, dig up or separate plants, cut out brush, dig holes for planting bulbs and seedlings, weed flower beds and garden plots, plus edge walkways and driveways.



Shovel-Lifting Straps can provide the leverage that can reduce the effort it takes to shovel snow, soil, sand, gravel, mulch, grain, or other material.



An is utilized for watering and/or applying herbicides / pesticides / fertilizer to limited-acreage row crops and lawns and for the chemical control of unwanted vegetation.



An ATV/UTV/Lawn Tractor-Towed Sprayer is utilized for watering and/or applying herbicides / pesticides / fertilizer to limited-acreage row crops and lawns and for the chemical control of unwanted vegetation. Most brands/models consist of: a UV-/chemical-resistant polyethylene tank (capacity ranging from 13 to 60 gallons) that rides on a two-wheeled frame or trailer; a diaphragm pump that runs off the vehicle's battery or a gasoline engine on the towed trailer/frame and dispensing 2 up to 6 gph under 60 psi pressure; and any of three spray-delivery systems-spot (hand-held wand) and/or broadcast, and/or boom spraying.



This Long-Handled Staple Setting Tool is designed to allow one, from a standing position, to push any length anchoring staple (e.g., garden staple) through fabric, liner, sod, etc. all the way into the ground. It eliminates the need to bend or kneel, to hammer or step on the staples to drive them in.) A magnetic head with 1/2-inch-deep groove is designed to keep the staple straight and from sliding out of the head.



The Speidel Weed Wiper is a wiping-type applicator intended to control weeds growing above any crop with a non-selective herbicide solution. Bracket-mounted in front or behind a small tractor, ATV, or other utility vehicle, the device consists of a perforated plastic pipe reservoir covered with absorbent canvas, which acts as the wick or wiping surface. The solution is gravity-fed through the holes in the pipe to soak the canvas.



The Dirt Dog Universal ATV/UTV Attachment Frame accommodates 12 different implements (e.g., aerator, box blade, carry-all, culti-packer, disc harrow, cultivator, rake, plugger, road-grader) designed to accomplish landscaping, food plot preparation, road maintenance, and land-clearing tasks.



A Double Wheel Hoe not only provides more stability than a single wheel model, but it also enables one to straddle the row when plants are small, so he/she can weed both sides of the row in one pass, significantly reducing time and effort. The U-bar double wheel model is designed to allow additional height clearance has a leaf-lifting feature that guides foliage through the chassis gently. The tool also accommodates a number of optional attachments (e.g., hiller, tines, beet knife/sweep, oscillating hoe, even a seeder).



The CultiSeeder Plot Planting Machine is a single-pass cultivator/planter that is designed primarily for small plots and can plant various size seed.



Many agricultural producers who are affected by spinal cord injuries, neuromuscular impairments, or leg amputations use a lift to gain access to their tractor, combine, or other agricultural equipment.



Spinner knobs offer better steering control for individuals with arthritis or prosthetic devices. Modern tractors with power steering require little steering effort, but a variety of conditions can make gripping a normal steering wheel difficult.

3.2 Orchard and Nursery Aids



Orchard Hydraulic Work Platform. Designed for fruit tree harvesting, thinning, and pruning, this between-row Orchard Hydraulic Work Platform consists of a trailer-mounted frame with a standing station on each side that goes up and down, in and out, independent of one another.



Pole-Mounted Fruit Picker is a wire basket at the end of an 8-foot pole, with wire fingers protruding out from the top of the basket. The fingers hook around the fruit and pull it into the basket, which the user then lowers to the ground and empties.



Foldable fruit grabbers



Nut Harvesting Tool, is able to pick up nuts, fruit, pine cones, etc. that are lying on the ground without having to bend over.





Small Berry Picker



Grape-Razor Vineyard Harvest Tool has a protected cutting blade and it is ergonomically designed to eliminate the possibility of cutting oneself when harvesting wine grapes.



The Bag-A-Nut Harvester is a manually pushed or garden tractor-pulled 'sweeper' used to pick up large quantities of almost any kind of nuts that have fallen off the trees.



Basemate Ladder Stabilizer is designed to equalize uneven terrain with the tap of one's foot, reportedly grounding the ladder as firmly as if on a flat surface.



Intended for orchard, nursery, and landscaping use, the Tripod Orchard Ladders have three legs: two base legs (called side rails) and a third leg (forming the tripod).



A Mechanical Tree Transplanter is a tractor-pulled, one to four-row implement that's designed for planting seedling trees on terrain not too steep or rough for mechanized equipment.



Hydraulic earth auger for setting posts, planting saplings, and installing supports for building or gardening work.



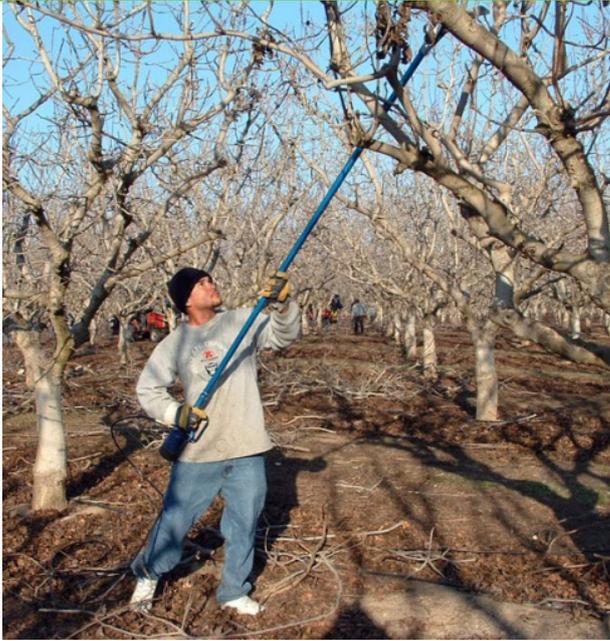
Battery-Powered Hand-Held Pruning Shears are designed to clean-cut branches (up to 2 inches thick)



Cut-and-Grab Lopper has a clamping jaw attached to the cutting blades that grabs and holds on to the pruned tree limb or shrub/debris branch, which allows one to more easily direct the fall of the branch away from the user then drop it where desired on the ground.



Gripless Pruner, developed by Bruce Bulko of Martinez, GA, is an electrical device for people with limited gripping ability. The pruner straps onto one's forearm and has a mercury switch that controls its operation. When the pruner is held in a horizontal position, it automatically turns on; when held more upright, it turns off.



Intended for fruit/nut orchard, tree farm/nursery, forestry, and green-area maintenance, this Pneumatic Long-Reach Pruner System is designed for use by a single operator or a two-person crew. All of the system's various packages consist of shears, fixed or telescoping extension poles, compressor, and air hoses.



Telescoping pruning equipment



Protective Pruning Sleeve is intended to prevent snags, punctures, abrasions, or cuts to the forearm during the pruning process or any other task where such arm protection is warranted.



Finger-fitting Ring Knives are designed to cut twine, plastic strapping, pallet wrap, tape, cardboard, even light-gauge wire; to prune small branches; and to harvest various vegetable and fruit crops quickly and safely, while reducing the risk of repetitive-motion injury.



Tree Watering Bags are designed to slowly leak water from release points on the underside to provide a constant source of moisture where needed most: the roots.



Portable, hand-operated Trombone Tree and Shrub Sprayer, designed primarily for the chemical spraying of trees, shrubs, and low-growing plants, can also be used to wash down structures, windows, vehicles, etc., all without having to either climb or stoop over.



Water polymer crystals are odorless, white water-absorbing polyacrylamides that increase the ability of soil to store water and nutrients around the root system and thus reduce the irrigation frequency and effort.

3.3 Production of Flowers and Vegetables



With an Aeroponic systems, commercial and home growers alike are able to produce a wide variety of vegetable, fruit, herb, and flower crops reportedly utilizing less than 10% of the space, water, and nutrients required by traditional soil-based growing methods and in significantly less amount of time. Aeroponics is a hydroponic system in which plant roots are suspended in air and intermittently soaked with a nutrient-rich solution.



Growup hydrogarden, with its vertical design, reportedly allows one to grow up to 20 plants in just 4 square feet of space, either indoors or outdoors.



Patio Raised Garden Bed Grow Box Kit with Watering System and Casters



Utilizing these Hydroponic Tower System Kits, one can grow 2 acres of plants in 1/4 acre of greenhouse space—and usually faster (e.g., strawberries bear in 6 weeks in spring, 8 weeks in fall). Each kit consists of stackable pots that rotate, swivel plates, premixed growing media, a 4- to 6-month supply of fertilizer, a pump, a timer, and a drip irrigation system.



In-Home Hydroponic Grow System has two main products designed to make growing a family's food indoors both easy and affordable.



Small-Scale Hydroponic Garden Systems can be accommodated in limited and unconventional growing areas, including apartment, patio, and even basement. Vertical Garden requires only 1-foot by 4-foot floor space to grow strawberries, lettuce, herbs, flowers, and other small plants. The Self-Watering Container Garden is a knee-level "garden" that allows one to control every ounce of water and fertilizer for producing all types of vegetables and ground fruits.



Raised Garden Beds are designed to be strong, long-lasting, and attractive, and it allows one control over both soil and drainage preferences.



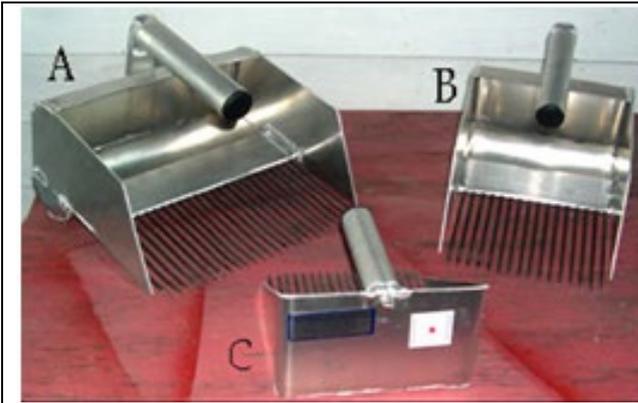
Mobile Gardening Bed is designed to allow one to grow food or flowers just about anywhere (e.g., rooftop, patio, garage, shed, even on a fence)-as long as there's a reasonable amount of light. The reusable (up to 5 years) soil sacks are reportedly stretchable, sturdy, permeable, and come with handles for easy moving.



VegTrug Raised Garden Bed, one can plant, tend, and harvest vegetables, herbs, and other crops at a comfortable height or from a wheelchair.



Single-Arm Gardening Equipment (SAGE) includes standard hoes, shovels, rakes, pole pruners, etc. that are modified to accommodate the needs of persons with one arm or limited mobility on one side of the body. Utilizing a support belt with a pivot bolt plus a handle extender (made of items available from any hardware store), these adapted tools improve posture while reducing stress of the wrist and back.



A Hand-Held Berry Harvesting Rake is designed to be both faster and more efficient than the hand picking of various berry crops, whether high-and/or low-bush blueberries, blackberries, huckleberries, lingonberries, gooseberries, currants, etc.



The Picking Assistant Motorized Lay-Down Work Cart is designed for use by field workers in carrying out hand labor for vegetable or ground fruit harvesting, planting, or crop-bed maintenance tasks. Among the cart's features-two forward speeds (22 or 44 ft./min.); reverse gear; dual high-torque motors; 12-volt battery (w/ charger); thick, vinyl-covered, adjustable padding; weather canopy w/ roll-up side curtains; adjustable picking height and row width; and height and tilt-adjustable picking trays. The cart is designed to be pulled to the crop site by ATV, tractor, pickup truck, or by hand.



Designed to be pulled, the Four-Row Pinpoint Seeder is used primarily to plant small to medium-size seeds in enclosed or limited areas like greenhouses and small plots. It can be set for four 2 1/4-, two 4 1/2-, or two 6 3/4-inch-wide rows. Among the tool's features are: four seed-hole sizes (accommodating carrot through pelleted-lettuce seed); individual in-hopper adjustable brushes (for precise seed metering).



With this all-metal, hand-held Stand 'n Plant Planter / Transplanter, one person can plant or transplant a host of different crops into prepared seedbeds, all from a standing position.



Ergonomic tools with soft grip upright style handle which helps keep your wrist and in a neutral position and helps reduce strain



Fork with Arm Support Cuff





Rolling work sheet with tool tray



Ergonomic garden tools to maintain the wrist in natural position while working



Easy grip long reach garden tools



Extendable Handle Hoe



Long reach gardening tools





Telescopic snapper



Telescopic weed puller-remover that can be used by individuals from either a wheelchair or a standing position.



Working Benches



Wooden stands for vertical gardening

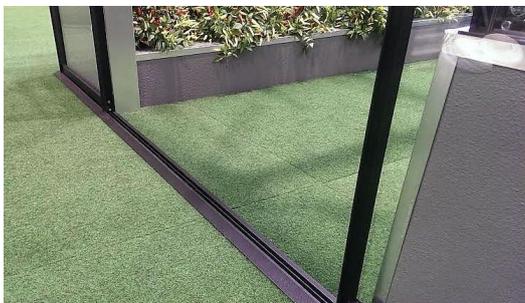
3.4 Greenhouse operations



A Fabric Raised Bed in the field or inside the greenhouse can increase yields, reduce weeds and other pests, improve soil condition, conserve water, and lengthen the growing season. In addition it can be reconfigured and relocated. The fabric that forms the bed is a flexible, heavy-duty pond liner material, which reportedly neither leeches chemicals into the ground nor absorbs them from the surroundings.

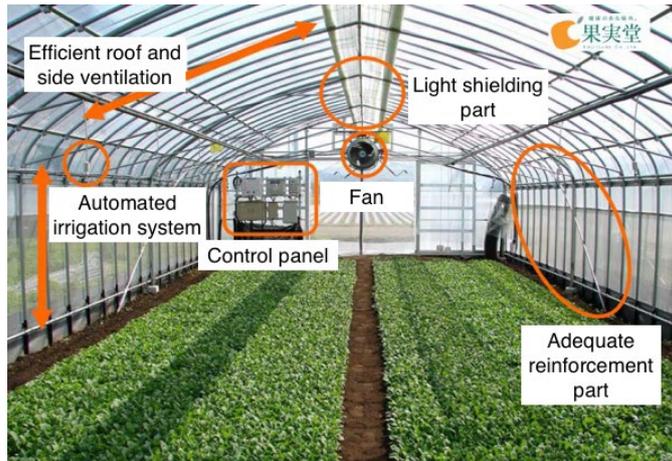


Accessible greenhouses with:
Low threshold entrance
Accessible pavement
Integral guttering
Double sliding doors
Elevated plant shelves etc





Greenhouse sensor systems and automations for Real Time monitoring and control of temperature, humidity, ventilation, shading, irrigation, fertilization, pest control etc





Grow-House Greenhouse provides the grower many of the features found in commercial models, yet at a fraction of the cost. The Grow House has a gothic-arch shape that provides structural strength and sheds rain and snow; 6-mil polyethylene glazing that captures 95 percent of available light; top and bottom vents that prevent overheating; and UVprotected PVC ribs that can't rust or rot.



The trigger-operated Hand-Held Seeder is used by home gardeners and commercial growers alike for starting plants in seed trays, soil blocks, raised beds, etc., and/or spot planting in fields. The device consists of a clear polycarbonate hopper that holds up to 1,000 seeds (depending on seed size), a disc with four openings (to accommodate different seed sizes), and a trigger mechanism designed to ensure quick and accurate seed drop.



Cordless drill-powered Quick-Cut Greens Harvester is designed to harvest over 150 pounds of salad greens an hour, without having to kneel or use a knife or scissors. The device consists of (1) an upright metal frame with crossbar and hand grip at the top and serrated blade at the bottom; (2) a rotating macramé brush that gently pulls the leaves into the oscillating blade, which cuts them off at ground level; and (3) a cloth basket to catch the harvested crop. The universal mount on the frame is designed to accept almost any kind of cordless drill, although 18-volt models reportedly work best.



Battery-Powered Bucket-Top Sprayer is designed to dispense liquids in about half the time as a hand-pumped sprayer. Running off a 12- or an 18-volt, the unit will reportedly operate for 2 or 4 hours on a single charge (depending on the liquid's viscosity). Among the sprayer's agricultural applications are fertilizing, pest control, weed control, sanitizing, and livestock cleaning/cooling.

3.5 Outdoor vehicles and mobility



All-Terrain Tracked Transporters are a self-propelled, rubber-tracked vehicle designed to carry materials, supplies, logs, debris, etc. to and/or from remote locations where heavy equipment, tractors, and other vehicles can't go.



The 56- by 24-inch, all-steel Kramble Motorized Utility Cart, with 16-inch pneumatic tires, is designed to transport loads weighing up to 2,000 pounds over even rough terrain. The cart's locomotion package includes: 12-volt DC electric rear drive, 66 foot-pound worm gear, and stainless-steel drive chain. Its on/off, variable-speed, forward/reverse control panel is located at the end of the 4-foot-long handle, which has a quick-release pin for manual mode.



Cart designed to collapse small enough to fit in the truck of a car or a storage closet with a pull of its spring-action handle; releasing the handle unfolds it. Used as a garden or barn cart, its removable front gate allows for the controlled dumping of soil, mulch, sand, gravel, feedstuffs, etc. Among the optional accessories include a riding mower trailer hitch and bicycle hitch.



All terrain wheelchairs either manual or battery-driven, comes in different styles which can allow the user to travel over rough terrain such as gravel, dirt, grass, sand, snow and even into water



All Terrain Vehicle converted to enable an individual in a wheelchair to independently operate it. It features an automatic wheelchair ramp and hand controls (Farm Again).

3.6 Other assistive equipment



Cordless grass trimmer



Cordless hedge trimmer



Long Handled Cut and Hold Pruner



telescopic ratchet loppers



Cordless Grass Trimmer with attached deck



Lawn Feed Spreaders



Plant Pot Mover Trolley



Expandable water hose



Garden Pruners with safety handle



Telescopic/extendable watering lance



Garden tool chart organizer

4. Health and safety considerations

It is well known that the disability model has changed over time beginning with marginalization and institutionalization of people with disabilities to incorporating and including people with disabilities into the environment by establishing built environments to meet the needs of people with all types of disabilities (Adams 2019).

Concrete measures are of prominent importance to enable the disabled farmers to work better in their farms with adequate confidence, competence and independence. These measures include: (a) Providing assistive technology, (b) Modifying work sites, equipments etc, (c) Providing adequate and appropriate training, (d) Providing funds and loans, (e) Reaching through extension activities (Perumal and Rajaguru 2016).

In terms of employment in agricultural sector existing disabilities and injuries may adversely affect both reaction time and motor skills. Therefore, individuals with sustained injuries and/or disabilities engaged in physically demanding and otherwise dangerous agricultural operations significantly increase their chance of secondary injuries. For example, a farmer with arthritis could lose his grip and fall; the fall causes the secondary injury. Assistive technologies are designed with these risks in mind to compensate for weaknesses and reduce the potential for further injury. However, unlike other industries, where products are tested for years, farmers with disabilities often need one-of-a-kind solutions for one of a kind types of needs. Therefore, the chance of the modification failing, causing injury to the individual or co-worker continues to exist.

Some agricultural operations, such as handling livestock, working on elevated locations, and machine maintenance, are considered as high-risk operations. For this reason, the straightforward approach for individuals with disabilities and primary injuries, in order to avoid secondary injuries, is to not take an active role in such activities. For example, activities have all been identified as high-risk operations. If

this is not an option, the operator must make every effort to adopt assistive technologies that can reduce the risk of secondary injuries (Grisso et al. 2014).

It is underlined that health and safety at work is of paramount importance in the European Union, comprising one of the key principles of the European Pillar of Social Rights. In agriculture as in most sectors the principal kinds of technology having, and likely to have in the near future, a lasting effect on working conditions and that are causing, or likely to cause, issues for workplace health and safety are automation/digitalization and the use of robots and thus an expert assessment of the potential risks requires further exploration (Cabrelli and Graveling 2019).

5. References

- Adams S.L. 2019. Environmental Issues in Exercise Promotion. In: Hollar D. (eds) *Advances in Exercise and Health for People With Mobility Limitations*. Springer, Cham
- Agrability. 2019. The toolbox assistive technology database of Breaking New Ground Resource Center, Purdue University. <http://www.agrability.org/>, accessed 2019.
- Behrens K. 2014. Small farmers' awareness of body mechanics and assistive technology. Ithaca College Theses. Paper 6.
- Cabrelli D. and R. Graveling. 2019. Health and safety in the workplace of the future. Policy Department for Economic, Scientific and Quality of Life Policies Directorate-General for Internal Policies. PE 638.434. European Parliament.
- Detang-Dessendre Cecile, Geerling-Eiff Floor, Guyomard Herve and Poppe Krijn, 2018. EU Agriculture and innovation: What role for the CAP?, INRA and WUR, 32p.
- European Commission (EC). 2017. The Future of Food and Farming. COM(2017) 713 final.
- European Commission (EC). 2018. EU agricultural outlook for markets and income, 2018-2030. European Commission, DG Agriculture and Rural Development, Brussels.
- Eurostat 2019. GDP per capita in 281 EU regions. NewsRelease 34/2019.
- FAO 2013. Disability-Inclusive Agribusiness Development. Regional Workshop on "Disability-Inclusive Agribusiness Development". 21-22 February 2013 United Nations Convention Centre, Thailand.
- FAO. 2018. The future of food and agriculture – Alternative pathways to 2050. Rome. 224 pp. Licence: CC BY-NC-SA 3.0 IGO
- Field W.E., Jones P. (2006) Disability in Agriculture. In: Lessenger J.E. (eds) *Agricultural Medicine*. Springer, New York, NY
- Fresco L.O. and P.J. Krijn. 2016. *Towards a Common Agricultural and Food Policy*. Wageningen University & Research. Holland.
- Gidarakou I. 2015. Women's Entrepreneurship in Rural Greece. *International Journal of Business and Management*. 10 (10):129-142

Gomda, A., Zakaria, H. & Sulemana, N. 2018. An examination of the link between participation of persons with disability in agriculture and food security the case of disabled farmers in Savelugu/Nanton municipality. *Ghana Journal of Agricultural Economics and Agribusiness* Vol 1(1):112-133

Grisso R., J. Perumpral, D. Ohanehi, and K. Ballin. 2014. *Assistive Technologies in Agriculture*. Virginia Cooperative Extension, College of Agriculture and Life Sciences, Virginia Polytechnic Institute and State University. Publication 442-084

Khetarpal A. 2013. Disability management in Agriculture; An all inclusive revolution. Paper presented during National Symposium on Disability Management in Agriculture and Farming, India

Mathew S.N., W. E. Field, and B. F. French. 2009. An assessment process to estimate the secondary injury potential of assistive technology adopted by farmers with disabilities. American Society of Agricultural and Biological Engineers, Reno, Nevada, June 21 - June 24, 2009 095836.(doi:10.13031/2013.27341)

Perumal P. and S. Rajaguru. 2016. Assistive technology and modification of worksite: Key to enabling the disabled in gardening activities. *Shanlax International Journal of Education* 4(4):1-9

WHO 2015. WHO global disability action plan 2014-2021. Better health for all people with disability. World Health Organization Library Cataloguing-in-Publication Data, Geneva.

Main sources of photos

<https://gr.pinterest.com>

<http://www.agrability.org/toolbox/?mode=browse>

<https://habitatcabarrus.org/>

<https://popkh.net/garden-scooters/>

<https://www.carryongardening.org.uk>

<https://nmeda.com/disability-gardening-tips/>

<http://www.hugehomecare.com/aids-for-daily-living/>

<http://greenthumbs.cedwvu.org/garden-ergonomics/>

<https://agrilifetoday.tamu.edu/>

<https://accessible-property.org/>

<http://www.fredshed.co.uk/gardeningfromawheelchair.htm>

<https://www.amazon.com>

<https://www.ebay.com>

<http://www.unitedspinal.org/disability-products-services/all-terrain-wheelchair>

<https://aliexpress.com>

<https://www.veseys.com>

<https://www.homedepot.com/>

<https://hydroponics.com>

<https://farmersfriendllc.com>

<https://civitasrewards.com>

<https://homeharmonizing.com>

<https://www.climatecontrol.com/blog/greenhouse-sensor-systems>

<https://sensprout.com>

<https://www.greenhousstores.co.uk/Greenhouses-With-Wheelchair-Access/>

<https://www.mutare.co.in/>

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