June 2024
Volume 1 • Issue 12

# Agring Bulletin

ARC • LNR
Excellence in Agricultural Research and Development

## CONTENTS



**Newsletter of the**
**ARC-Natural Resources and Engineering (ARC-NRE)**
Agricultural Engineering campus, Silverton
***Editor: Dr Macdex Mutema***
*E-mail: mutemam@arc.agric.za*
*Website: www.arc.agric.za*

## *A word from the Editor …*

*Greetings to you our dear readers.*
*Welcome to the 12th edition of our external newsletter, Agring Bulletin. We take this opportunity to thank you all for reading our newsletter, which appears twice per annum. We strive to keep publishing articles with information that you will always find helpful in this era where clean energy resources and high efficiency in water use are topical.*

*Best regards*
*Dr Macdex Mutema*


*Dr Macdex Mutema*
*Editor (Snr. Researcher)*

***Editorial Committee members:***
** Dr Idan Chiyanzu (Snr. Researcher)*
** Dr Tingmin Yu (Snr. Researcher)*
** Ms Elmarie Stoltz (PRO: layout/design)*

# The prospective adoption of small wind turbines on vehicles for agricultural utility

– by Ms Perm Mthethwa

Wind energy, after solar energy, is one of the fastest-growing energy sources globally. While it is mostly large wind turbines that are well known, small wind turbines are also getting popular, although they are not well researched. Wind energy is an abundant energy source that is easily created and made accessible for moving vehicles. Even though the wind turbine operates on a free energy source, the installation may be costly due to the high prices of components such as the generator, inverter and battery, but overall, it has zero running costs except for minimal maintenance.

Electrical energy / electricity generated by the wind turbine generator can be used to power the car's battery, air conditioner, and all other electric devices. In the agricultural context, it has been realized that the power generated by the wind turbine can be used to power cooling or refrigeration units for fresh produce transportation. Figure 1 shows a small wind turbine mounted on a bakkie for power generation. Since most smallholder farmers use open transport to move their fresh produce (fruit and vegetables), even in hot conditions, this technology can assist in powering the movable or trailer cooling units. This way farmers will guarantee the freshness of their produce until it reaches the market, ensuring that they make good profits from their harvest.

**Apparent wind speed**
When one travels in a car on an open road and opens the window, one can expect to be hit by a gust of wind. This is the apparent wind speed that is generated by a moving car. At a time when the world is suffering from climate change and an energy crisis, it is important to look for alternative renewable energy sources to help mitigate extreme global warming, ultimately leading to rapid climate change.

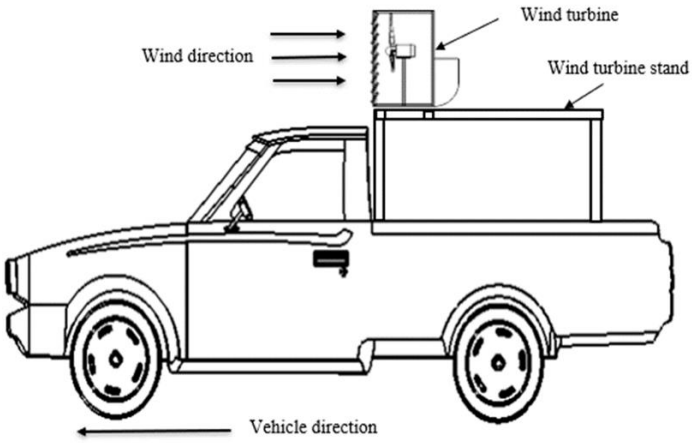



*Figure 1: Small wind turbine prototype mounted on a bakkie*

What if one could use the wind energy generated by moving vehicles to operate a wind turbine and generate electrical energy?

**How does the wind turbine operate?**
The components of a wind turbine include the electric generator, the rotor, the rectifier, the inverter and the battery storage. So, when the incoming wind blows on the turbine rotor, it causes it to rotate. This rotation results in the mechanical movement of the connecting shaft coupled to the electrical generator which ultimately generates the electric energy to power any electrical components or appliances using an inverter. The rectifier is used to convert AC power to DC power. The inverter is required to correct the DC power into AC power that is usable by the car or cooling unit after being stored in a battery. The permanent magnet synchronous generator (PMSG) is the machine or device used to convert mechanical energy into usable electrical energy.

*… continued on next page*

... continued from previous page

**Parameters to consider when designing a wind turbine**

Although large wind turbines depend on the large size of the turbine rotor (propeller) and a gearbox to generate electrical energy in regions with low wind speeds, the operation of small wind turbines is based on optimizing the blade design and using the high apparent wind speed created with the car motion to account for the small size of the wind turbine. The following parameters are essential to consider when designing a small wind turbine, including the rotor diameter, wind speed, rotor blade material and fixed rotor position.

***Rotor diameter:*** The first compromise that must be made in the design of small wind turbines is the rotor size/diameter. The size of the wind turbine mounted on a moving vehicle must be small because of the limiting size of the car. This means that it is extremely small in comparison to the large wind turbines we are used to seeing, and more like the size of a house fan. Therefore, for these wind turbines, the rotor diameter is +/- 1m. In order to make up for the small rotor size, one has to optimize the blade design.

***Wind speed:*** In the case of small wind turbines, the wind speed is the most important design parameter that can be manipulated to get the desired power output along with the swept area, the air density and power coefficient of the wind turbine.

***Rotor blade material:*** The material from which the rotor blades are made is very important because it affects the aerodynamic performance of the wind turbine. It determines the strength and sustainability of the wind turbine but must also be lightweight for its aerodynamic functionality. While most large wind turbine rotor blades are made from metal, glass fibre-reinforced polymers (GFRP) or carbon fibre-reinforced polymers (CFRC), one of the simplest and cheapest materials used to make rotor blades for small wind turbines is polyvinyl chloride (PVC) pipe. This is because the PVC pipe material is weather-resistant, light in weight, can be easily heated and shaped into form, in addition to being widely available.

***Fixed rotor position:*** Since the incoming wind is from one direction only, i.e. the vehicle's travelling direction, the rotor is fixed/stationary at one position, and this eliminates the need for the furling mechanism.

**How to go about designing a small wind turbine**

The Blade Element Momentum (BEM) theory and QBlade can be used for the design and optimization of the rotor blades. The BEM theory/equations are used to design the blade. QBlade – a free application that can be downloaded off the internet – is then further used to simulate and optimize the blade's design. In a study done by the author, a small wind turbine prototype that can be mounted on top of a bakkie was developed as shown in Figure 2. When designing a wind turbine, it is critical to recognize that for every component sizing computed, one has to acquire twice the required size simply because most devices have an efficiency of 50% at most. Although purchasing twice the size of the computed value is costly, it can surely benefit the end user in the long run. ■

***Enquiries:*** MthethwaP@arc.agric.za

(a)

(b)

(c)

*Figure 2: Small wind turbine prototype showing (a) the front side of the wind turbine with a louvre mechanism, (b) the open louvre mechanism, and (c) the inside of the small wind turbine prototype*

# Knowledge Exchange Day: Sharing information on the field performance of Agri-mats

– by Dr Macdex Mutema, Mr Segolo Phasha, Dr Khumbulani Dhavu, Ms Sandisiwe Mahlamvu, Ms Manoshi Mothapo, Dr Adornis Nciizah and Mr Lulama Sombalo

ARC-NRE, in collaboration with the Limpopo Department of Agriculture and Rural Development (LDARD), is implementing a DALRRD funded project on the promotion of Agri-mats as a soil surface mulching technique at Mphanama and Ga-Radingwana villages in Sekhukhune District. A Knowledge Exchange Day was held on 13 June 2024 to enhance information dissemination at Mphanama. The event aimed at showcasing to the community how Agri-mats installed in a sorghum crop performed during the season. This was geared at providing an opportunity for the entire community to learn about the Agri-mats and how they have performed under the management of farmers.

*Dr Mutema speaking to farmers at the event*

*Mr Phasha speaking to farmers at the event*

*Female farmers expressing their opinions*

It was also the aim of the event to provide a platform where farmers could ask questions and get answers on matters of an agricultural nature.

*Farmers listening to presentations and discussions*

A total of 67 people, including 8 LDARD and ARC officials, attended the Knowledge Exchange Day. The farmers were enthusiastic about the mulching technique and are looking to the future with great hope. They were most pleased by the bigger quantity and size of sorghum heads on the Agri-mat treatment, which signalled its high potential to improve crop yield, thereby addressing the problem of food insecurity. However, there is a need to address pest problems, especially birds and aphids. Moles were also indicated as a problem in some areas of the community. ■

***Enquiries:*** MutemaM@arc.agric.za

# Simple steps for the planning and designing of drip irrigation systems

– by Mr Milton Petersen

***Although contractors have accepted drip irrigation as a good water management practice, proper planning and design continue to raise questions. Drip irrigation systems are not necessarily more difficult than other systems, they are simply different.***

By doing your homework and planning, you can implement drip irrigation systems that use water responsibly while allowing landscapes to flourish.

If you want to irrigate any non-turf area including flowerbeds, ground cover, street medians, vegetable gardens and hanging baskets, drip irrigation maybe your most efficient option.

Not only does drip irrigation save water, it also reduces the amount of time spent on maintenance. By only watering the plants you want to grow, you can avoid providing water for unwanted weeds in open areas, reducing the need for herbicides and time spent manually pulling up weeds.

When deciding whether a drip irrigation system is appropriate for your particular application, consider the following important factors:

***Installation costs:*** In most cases the cost of materials will be similar for low volume and conventional irrigation systems. The cost of labour, however, will be less for a low volume system because you can often install it at or near the soil surface, thus requiring less trenching.

***Size of area:*** Generally non-grass planting areas of any size can use low volume irrigation. There are, however, two considerations, namely plant density and maintenance. For example, a large densely planted area with a homogeneous plant material generally requires uniform watering over a fairly consistent root depth and can be irrigated with broadcast methods. However, the fact remains that drip irrigation can provide adequate hydration to any area, small or large.

***Possibility of vandalism:*** In areas where vandalism can be a problem, it is important to design a system that can be installed below ground as much as possible, with exposed components placed out of sight. Drip irrigation is an excellent choice for these types of situations. A properly designed drip irrigation system is much more vandal-proof than a conventional system.

***Safety:*** Low volume systems provide greater safety by reducing run-off on walkways and paved areas, and overflow into the street or pavement.

***Intended use:*** Low volume irrigation may be less appropriate for sites with heavy traffic, because the expose tubing can be damaged. Frequent soil cultivation may also damage the tubing.

Lastly, a drip irrigation system can save up to 50% of the water used by a conventional irrigation system. However, this type of performance can only be achieved with careful planning and proper design. ■

***Enquiries:*** PetersenM@arc.agric.za

# Training of University of Venda Engineering students

– by Dr Macdex Mutema

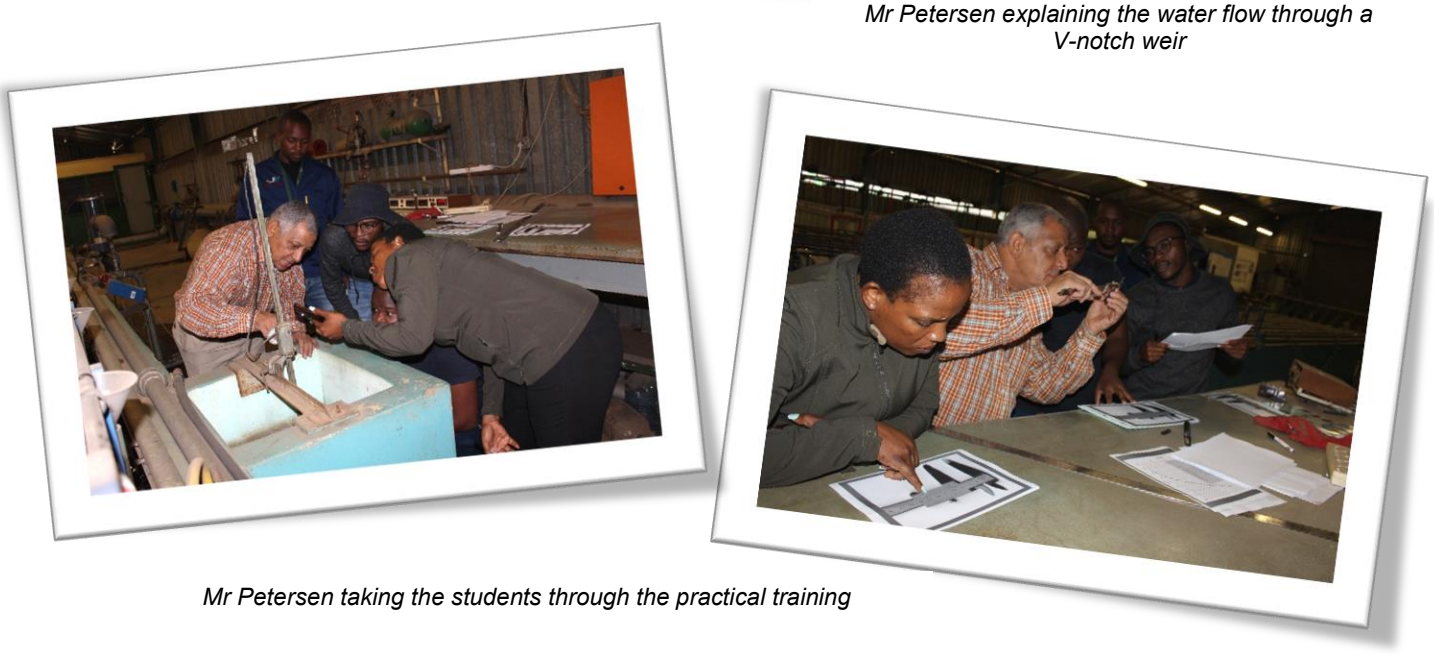
Two students from the University of Venda, who are registered for the BSc Agricultural and Biosystems Engineering degree, visited the ARC-NRE Agricultural Engineering campus on 12 April 2024 to learn about open channel flow measurements. They were accompanied by a Chief Technician. The Irrigation and Agricultural Infrastructure Engineering programme hosted them for both theoretical and practical training in the irrigation laboratories. ■

***Enquiries:*** *MutemaM@arc.agri.za*

*Dr Macdex Mutema, together with Ms Sandisiwe Mahlamvu, giving a lecture on flow measurements to the two students*

*Mr Milton Petersen, with the assistance of Mr Karabo Moreme, explaining the drippers test bench*

*Mr Petersen explaining the water flow through a V-notch weir*



*Mr Petersen taking the students through the practical training*

# Training of University of Venda Hydrology students

– by Dr Macdex Mutema

A group of 19 students from the University of Venda, Department of Earth Sciences visited the ARC-NRE Agricultural Engineering campus on 20 May 2024 for training on irrigation practices, both theoretical and practical. The training included aspects such as open channel flow hydraulics, pipe flow and energy loss, pipes and resistance to flow, total energy losses and energy gradient lines, hydrostatic pressure and forces, hydrodynamic concepts and measurements, concepts and computations of specific energy and a hydraulic jump. They were hosted by an Irrigation and Agricultural Infrastructure Engineering team comprising Dr Macdex Mutema, Mr Fanie Vorster, Mr Milton Petersen and Mr Karabo Moreme. ■

***Enquiries:*** *MutemaM@arc.agri.za*

*Dr Macdex Mutema presenting a lecture to the students as part of the theoretical training*

*Mr Karabo Moreme and Mr Milton Petersen explaining the drippers test bench*

*Dr Mutema and Mr Petersen explaining how to read vernier calipers measurements*

*Wrap-up session: a student presenting to fellow students what laboratory exercise his group did and the results they obtained*

*Group photo of the University of Venda students with ARC-NRE staff*

# ARC-NRE exhibits at the 56th annual Nampo Harvest Day

– by Ms Elmarie Stoltz

The Agricultural Research Council consistently participates in the annual Nampo Harvest Day by hosting a comprehensive corporate exhibition at the event held in Bothaville, Free State. The ARC-NRE Soil, Climate and Water (SCW) and Agricultural Engineering (AE) campuses took part in the exhibition again this year, together with the other ARC campuses. Nampo 2024, which took place on 14-17 May, saw a total attendance of 86 474 with 865 exhibitors, and the ARC was a significant contributor to the success of this event. ■

***Enquiries:*** *StoltzE@arc.agric.za*


*ARC-NRE (AE and SCW) exhibition stand at Nampo 2024*

*From left: Ms Elmarie Stoltz (AE), Ms Bongi Ndhlovu (SCW) and Dr Kobus Anderson (SCW) at the ARC-NRE exhibition stand at Nampo*


*Ms Stoltz explaining animal housing and handling facilities to the children at the ARC-NRE exhibition stand at Nampo. They were quite excited by guessing how much the bull on the scale weighed!*


*Ms Ndhlovu and Dr Anderson engaging with visitors at the ARC-NRE stand at Nampo*

# New publications

## Processing of Nuts

**Authored by Ms Theresa Siebert**

*Published: February 2024*

A “nut” is defined as a fruit that consists of a hard or tough shell that protects a kernel, which usually is edible. This publication covers the following nut-based products (some short descriptions are given as illustrations):

**Almonds:**

- Almond flour.
- Almond butter – this product is like peanut butter in appearance but its texture is slightly oilier. The flavour is predominately that of roasted almonds. Almond butter has a wide range of food applications especially in the confectionary industry.
- Almond paste – almond paste or marzipan is used in confectionary, pastries and baked goods for decorating purposes. It may also be spread or shaped and enrobed in chocolate.
- Roasted almonds – both commercial- and small-scale processing are discussed.
- Almond oil – this is a rich source of both macro- and micro-nutrients. The oil is mostly used in the food industry for flavouring and in the cosmetic industry as it contains vitamins, minerals, fatty acids, and antioxidants which are seen as beneficial for skin treatment.

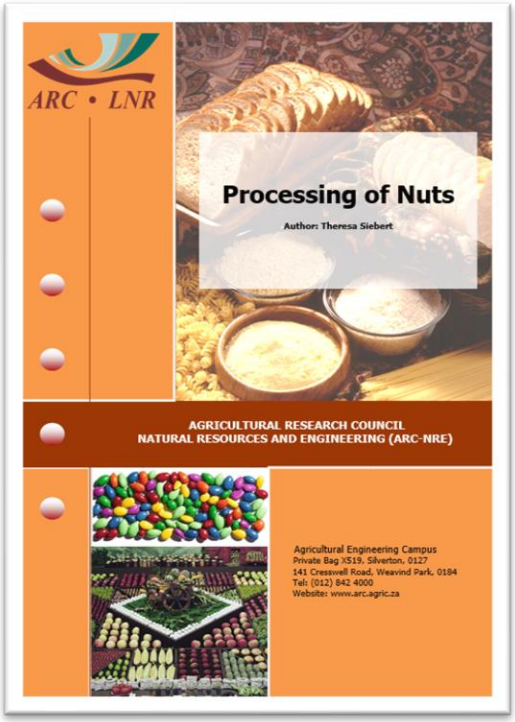
**Macadamias:**

- Roasted or fried macadamias – the macadamia nut is regarded as one of the world’s finest gourmet nuts because of its fine crunchy texture and rich, creamy colour, and relatively low volumes of production. These features have led to the promotion of macadamias as a luxury dessert nut.

**Pecans:**

- Pecan oil – this product is mainly used as a high temperature cooking oil due to its high smoke point. This feature also makes it ideal for deep frying. Pecan oil has a mild nutty flavour that enhances the flavour of the dish components, which means it also finds application in salad dressings and dip sauces.
- Toasted and salted pecans.

***Enquiries:*** SiebertT@arc.agric.za




*Almond butter*

*Marzipan fruit sculptures*

*… continued on next page*

… continued from previous page

# Processing of Citrus Fruit

**Authored by Ms Theresa Siebert**

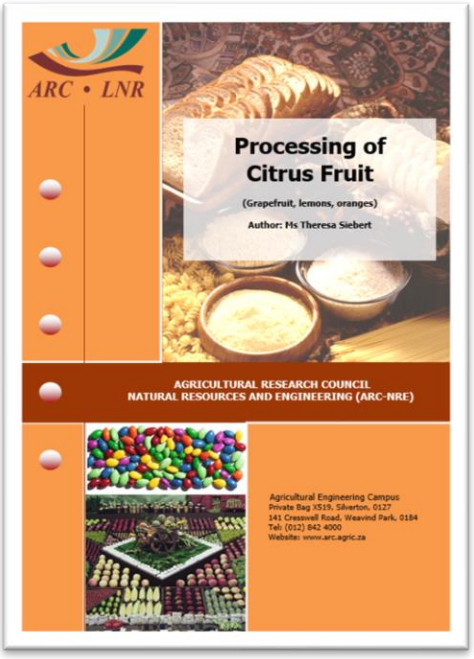
*Published: June 2024*

South African farmers facing current economic realities are searching for new options of surviving and expanding their business. One of the opportunities to grow markets, turnover and profits is by adding value to farm produce. Farmers need to choose carefully based on sound information and knowledge of the options available.

This publication covers food processing methods for **grapefruit**, **lemons** and **oranges**, including the following:

- Grapefruit is canned in segments or wedges in sugar syrup of various strengths or artificially sweetened liquor. The canned product is a convenience product, used to replace the fresh product. It has a long shelf life, thus extending the availability of seasonal fresh produce. Its uses include as a breakfast food and in bakery products.
- Lemon juice concentrate – concentration and freezing are the best long-term preservation options for lemon juice. The concentrate thus serves as a semi-processed product that can be further processed into various beverages such as lemonade or juice blends, or purely an acidulant.
- Dried orange peel is usually a by-product from juice extraction or other processes. The peel is preserved by drying and finds applications in cereals, marmalades, spice mixtures, baked products sauces, and herbal teas.
- Pectin is a water-soluble fibre that can form a gel when in the right combination with acid and sugar. Many parts of citrus fruits contain pectin, namely the flavedo, albedo, membrane and juice vesicles. The raw material most often used for the production of pectin is the spent peel from juice and/or oil extraction lines. The peel may be processed wet but is mostly dried and stored in a semi-processed form. The average yield of pectin from lemon peel is approximately 3% by weight.
- Orange wine is an alcoholic beverage that is produced through the process of fermentation of orange juice in much the same way as grape juice is fermented to produce wine. The juice from Valencia oranges is used for making orange wine. The final product is sweet with an alcohol content of 14.5%, and is served as an aperitif or dessert wine. ■

***Enquiries***: siebertt@arc.agric.za




*Dried orange peel*

*Orange juice*


*Congratulations to **Dr Sipho Sibanda,** our Research Team Manager: Agricultural Mechanization, Agro-processing and Renewable Energy, for participating in the 2024 Comrades Marathon and finishing in an impressive 9 hrs, 36 mins!*