TECHNICAL BULLETIN

No. 50, 2023

Development of a Solar Cabinet Dryer for Vegetable Seeds

With an annual output of about 13 million tons, Bangladesh ranks third in the world in vegetable production. Vegetable is produced round the year in the country, and about 2000 metric tons of vegetable seeds are produced annually from around 0.58 Mha of land. Quality seeds alone can increase vegetable yield by 15-20%. Moisture content plays a major role in determining the shelf life of seeds. Vegetable seeds normally contain 60-80% moisture at the stage of physiological maturity. The seed moisture content needs to be reduced to a safe level of 8-9% by sun or air drying or mechanical drying to preserve seed quality during storage. Seeds should be dried at a constants and optimum temperature to ensure seed quality but in the traditional sun drying method, it is not possible to maintain a constant temperature due to variations in solar radiation. Sometimes, continuous rain occurs for a few days or even for a week, spoils the whole amount of seeds restricting traditional sun drying. In this backdrop, an eco-friendly dryer is needed for drying vegetable seeds to preserve seed quality and reduce the loss of seeds. Solar drying is a promising technology in this respect especially for small farms in Bangladesh. A solar assisted hybrid dryer was designed, fabricated and tested for drying grain seeds in 2010 by the Farm Machinery and Postharvest Process Engineering (FMPPE) Division of BARI, Gazipur with the financial support of KGF. The dryer was found to be suitable for drying 200-300 kg of grain seeds, but to date there is no locally made seed dryer available for drying vegetable seeds at the farm level. This KGF financed project attempted to design and fabricate an eco-friendly cabinet solar dryer for drying of vegetable seeds to reduce seed losses and produce good quality vegetable seeds.

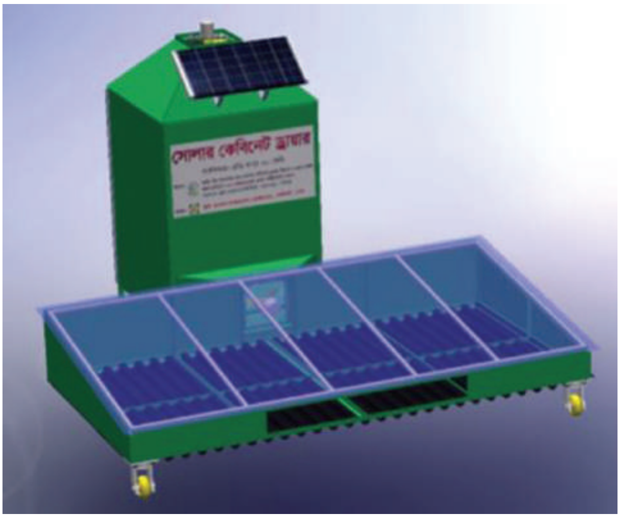

Fig. 1. Isometric view of the solar cabinet dryer developed at BARI

Methodology

Two solar cabinet dryers (large and small) were designed and fabricated at the FMPPE Division, BARI, for drying of 10-12 kg of moist vegetable seeds at the rate of 2-6 kg per batch.

The dryer was designed to generate desirable temperature (<45°C) from solar radiation suitable for vegetable seed drying. They were fabricated with locally available materials such as, MS box, MS flat bar, MS angle bar, MS sheet, GP sheet, SS net, insulation materials, DC fan, PV module, polyethylene sheet, cork sheet etc. These are indirect solar cabinet dryers consisting of a drying chamber, a collector and an auxiliary heating source (electric heater). To reduce temperature differences among the trays of the dryer, two additional dry heaters of 500 W capacity were vertically incorporated adjacent to the upper two trays. A 12 V battery was connected for running the fans in absence of electricity or insufficient sunshine during drying operation. The battery could be charged by a controller through a solar panel. A special feature of the dryer was that it could be operated on a sunny day using solar radiation and on a rainy or cloudy day or at night using auxiliary electric heaters. Performance of the solar powered vegetable seed dryer was evaluated with red amaranth and sweet gourd seeds. Modification of the dryer was done and a prototype fabricated. Dried seeds (moisture content of 7.0% on the wet basis) of red amaranth (7.95 kg) were used for evaluating the performance of the dryer. The dried seeds were wetted with water at 18% moisture content (wb). The dryer was also tested for freshly harvested seeds of sweet gourd (616 g) collected from a local wholesale market. Ambient air temperature, ambient air relative humidity, global solar radiation, temperatures at different points in the collector and drying chamber, airflow at the inlet and outlet of the drying chamber, moisture content of seeds were recorded at one hour intervals. The price estimation, economic analysis of the dryer and seed quality were determined. Workshops, adaptive trials, and farmers' training were conducted. A booklet on "Manual of introduction and uses of solar cabinet dryer" was printed.

Results and Outputs

The moisture reduction of amaranth seeds during the drying period is shown in Fig. 2. The moisture content was reduced from an initial moisture content of about 20.78% (wb) to the final moisture content of about 7% (wb) in 6 hours maintaining an air temperature of 42.8°C and relative humidity 30% when the mean global solar radiation was 550 kW/m2. The moisture content of amaranth in the drying chamber was almost uniform.

The moisture content was of sweet guard seeds was reduced from 41.59% to 9.23% (wb) in 6 hours (Fig. 3) maintaining air temperature of 42.70 °C and relative humidity 40% when only electric heaters of 4kW were used. It was observed that moisture content of seeds in bottom tray was 1.13% lower than that of upper tray. In total 2 kWh electric energy was used for drying of 616g moist (41.59%) sweet guard seeds for 6 hours.

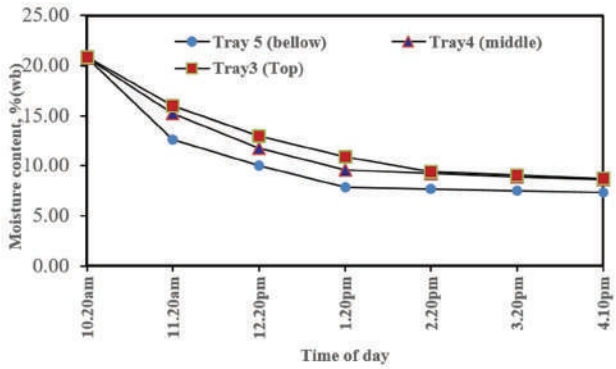

Fig. 2. Variation of moisture content of amaranth seeds with drying time

The moisture content of BARI Tomato-14 from was reduced 58% to 7.8% (wb) in 9 hrs maintaining an air temperature of 42.3°C and relative humidity 35% when the mean global solar radiation was 600 kW/m2.

Seeds of amaranth dried up to 7% (wb) in the solar cabinet dryer germinated at the rate of 81% in filter media. The germination % of sweet guard after drying up 9.23% moisture content (wb) was 98 in sand media, and BARI Tomato-14 seeds germinated at the rate of 85% in filter media after drying up to 7.8% moisture content (wb).

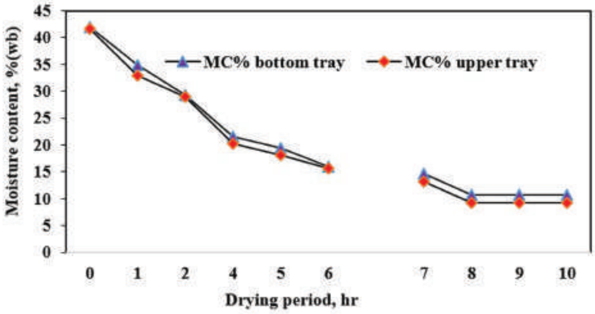

Fig. 3. Change in moisture content of sweet guard seeds with drying period

The estimated prices of the dryers (large and small) were Tk. 80,000 and Tk. 50,000, respectively. An economic analysis was done simulating both machine ownership and custom hire situations in terms of fixed and variable costs incurred. The fixed cost included two costs items namely, capital consumption and shelter, and variable costs included labor, electricity, R&M, and material. The costs of drying in the large and small dryers were found Tk. 117163/kg, and the the payback periods of the dryers were estimated to be 75 days and 64 days, respectively. The BCR calculated on net returns of the dryers were was 1.14 and 1.04, respectively. The break-even points (BEP) were calculated including fixed cost and variable costs. The BEPs of the dryers (large and small) were 1100 and 400 hours per year, respectively. It was concluded that seed drying by the dryers (large and small) could be profitable for traders when the annual use of the dryers exceeded 1100 h and 400 h, respectively.

Linkages between BARI and manufacturers for producing solar seed dryers and sale and after sales services to farmers and seed growers. Awareness building was done) through six adaptive trials, training (6 batches of 294 male and 66 female farmers), publishing booklets, newspaper articles and electronic media broadcasts.

Expected Impact

The dryer temperature is adjustable, so it would be suitable not only for vegetable seed drying but also for drying spices and various other food items. The machine will significantly reduce seed damage and waste due to cloudy weather or rain. The dryer can save seed drying time by 75% compared with the traditional practice of sun drying and save farmers and seed growers the drudgery and uncertainty of sun drying. Seed growers/farmers, seeds companies and entrepreneurs (custom hiring basis) can use the dryer for drying of high-value vegetable seeds.

Recommendations

The solar dryer is an economically viable, environment and women friendly machine that can be operated using only solar energy, electric energy or both. The machine need to be popularized among farmers and seed business entrepreneurs. Further research is needed to fine-tune the dryer operations in terms of setting the most suitable temperature and humidity levels for quick and optimum drying of seeds of different cereal, legume, vegetable and oilseed crops.

This Technical Bulletin has been prepared on the basis of technical information available from a completed BKGET-KGF Funded CGP Project, the details of which are given below:

Project Code and Title: TF 55-AE/17. Development and Adoption of a Solar Cabinet Dryer for Vegetable Seeds

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Project duration: 10 January 2018 to 9 January 2023

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Krishi Gobeshona Foundation (KGF)

Published by:
Krishi Gobeshona Foundation, AIC Building, 3rd Floor, BARC Campus, Farmgate, Dhaka-1215, Bangladesh, Cell: 01729 480988, Website: www.kgf.org.bd, e-mail: kgf-bd@kgf.org.bd