DRYING RESEARCH AND EXTENSION AT THE FACULTY OF AGRICULTURAL ENGINEERING AND TECHNOLOGY, AND THE CENTER FOR AGRICULTURAL ENERGY AND MACHINERY OF THE NONG-LAM UNIVERSITY HOCHIMINH CITY (Formerly: University of Agriculture and Forestry)

A SKETCH OF 20-YEAR EVOLUTION [#]

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Introduction

From 1981, the Faculty of Agricultural Engineering and Technology (**FAET**) of the University of Agriculture and Forestry (UAF-HCM) have been engaged in activities related to research and extension or transfer of technologies, among which is the outstanding area of drying machinery. The basic principle has been: The research should serve the production sector, including farmers and processors.

In January 2001, the Center for Agricultural Energy and Machinery (**CAEM**) was established, with the mandate of research and development to serve the production in three areas: (a) Energy in agriculture, with focus on renewable energy; (b) Agricultural machinery for field and farmstead production; and (c) Agricultural and food processing machinery. The Center continues the FAET tradition of serving the production sector in a full-fledged pattern for research, with funding and staff time mainly for research and extension activities.

Research in drying at FAET and CAEM has been diversified with different principles, capacities, and investments. Following are the summary of results in drying research and extension, of which the most successful in terms of technology transfer are discussed in more details.

Flat-bed dryer SHG

Our research has come up with several models with capacities ranging from 1 to 12 tons per 8-hr batch. Most popular are the SHG-4 model (4 ton/batch; investment: US$2000)

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and SHG-8 dryer (8 ton/batch; investment: US$3000) for grains and seeds (Figure 1). These dryers include new features from research results, some of which were patented, as follows:

- A rice husk furnace with cylindrical combustion chamber which traps ash and spark more thoroughly compared to existing box-type furnaces (Fig.2). .
- An axial-flow fan with correct air-flow and pressure for the drying requirements, and with pretty high efficiency compared to other locally-made fan.
- A new "side-duct" drying bin (Fig.1) holding 4 t of paddy. Drying air enters a side duct, and turns right into side openings to the plenum . Tests with this new bin in 1994 showed that exit air velocity on the grain surface was acceptably uniform, resulting in the grain final moisture differential of less than 1.8 % between any two points on the 3m*8m bin . This differential is between 2.5 to 5 % in "classical bin" where air enters at one end of the plenum chamber .

Figure 1: SHG-8 dryer, developed in 1996; over 600 units are now in the Mekong Delta of Vietnam

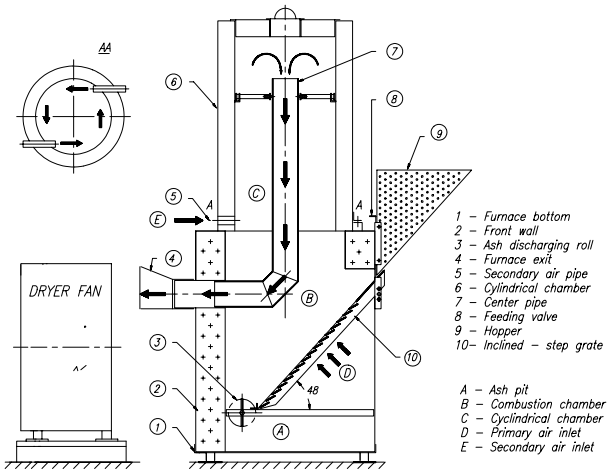

Figure 2: Rice husk furnace with cylindrical combustion chamber

Extension of these dryers has been as follows:

- About 70 units have been installed directly by FAET staff throughout the country, from the northernmost province of Ha-Giang to the southernmost province of Ca-Mau.
- About 600 units have been installed by transfer of technology to 10 agencies/institutions, among which 500 units installed in Can-Tho and Soc-Trang Provinces. The design and fabrication of the fan ---the heart of the dryer system--- have been also transferred to 16 manufacturers throughout Vietnam. All *without royalties* in order to reduce investment for farmers. One manufacturers in An-Giang has fabricated more than 300 fans for SHG-dryers.

- The SHG-4 dryer has been transferred to PhilRice (Philippine Rice Research Institute) in 1994. Up to 2001, they have installed about 100 units throughout the Philippines.
- Most recently (April 2002), the SHG-4 dryer has been transferred to Bangladesh, with good results in drying parboiled paddy.

The budget for the in-country extension of the SHG flat-bed dryer was mostly from client-farmers under the format of a purchase contract. On the other hand oversea transfers were covered by recipient agencies.

"Very-low-cost" SRR dryer

The design is based on the principle of low-temperature drying (a few degree above ambient air), and aims to small-scale farmers cultivating less than 0.5 ha, but living in area with electricity available. The investment for this patented SRR dryer is cheap, only US$80, with the drying capacity of one ton in 38 hours. The SRR-1 dryer (Fig.3 and 4) consists of three components: a two-stage axial fan, an electric heater, and a bamboo-mat drying bin.

The drying bin consists of two concentric bamboo-mat cylinders of 0.4 m and 1.5 m diameter, and 1.1 m high. The bin can hold one ton of paddy.

The fan is driven by a 0.37 kW (0.5 HP), single-phase, 2800-rpm electric motor. Two 350mm-diameter, 7-blade rotors are mounted on both ends of the motor shaft and inside a steel casing. The plastic rotors are locally made, and readily available in the market as spare parts of car radiator. The fan is positioned on top of the inner bamboo-mat cylinder. The airflow is 0.35 m^3/s at 300-Pa static pressure.

The heater is a 1000-watt resistor from the electric stove; it is mounted beneath the lower rotor. Supplemental heat from the resistor is used selectively at night or during continuous rain. Later, a coal stove was added to reduce the electrical bill for the dryer.

Extension activities of SRR dryers has been most active from 1995- 1998:

- About 300 SRR dryers have been installed by the UAF extension program throughout the country in collaboration with Provincial Extension Centers. The fabrication technology has been transferred to 4 small manufacturers. To date, it is estimated that over 1400 SRR dryer are used throughout Vietnam, of which 10 units in 8 Provinces of Northern Vietnam, 200 units in Central Provinces, and the balance in Southern Provinces.
- SRR-1 dryers have been demonstrated and the fabrication technology transferred to 5 Asian countries, namely Myanmar, Philippines, India, Bangladesh, and Indonesia; the evaluation has been positive. Twenty units have been produced in Bangladesh.

The budget for research and extension of SRR-1 dryers (excluding the purchase price for the dryer) were from the GTZ in collaboration with IRRI (International Rice Research Institute, Los-Banos, Philippines).

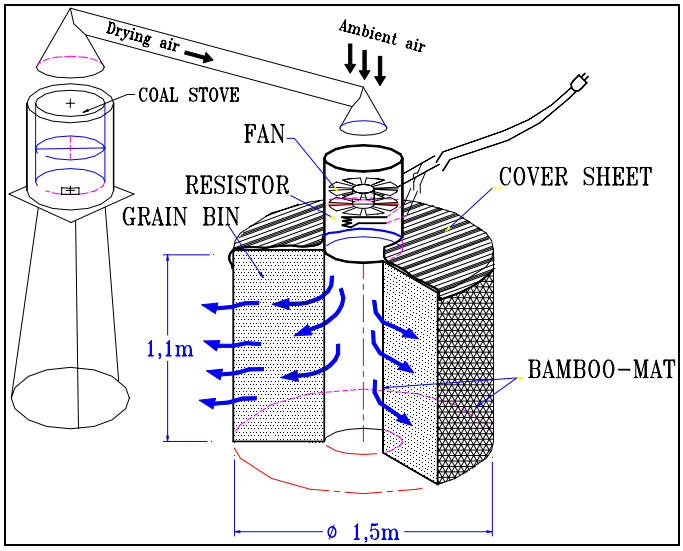

Figure 3: Construction of SRR-1 dryer with coal stove

Figure 4: SRR-1 dryer, over 1000 units promoted throughout Vietnam

The STR dryer

This is a modified version of the SRR-1 dryer; it operates in the temperature range similar to that of a flat-bed dryer. The drying time is reduced to 16 hours/ 1 ton, but requires manual labor for mixing. The investment is slightly higher (US$100) compared to that of the SRR-1 dryer.

The fluidised-bed dryer STS-1 and STS-4

Following the pattern developed in Thailand, the fluidised bed STS-1 and STS-4 dryers were designed and tested in 1994-1997. The technical performance was good: Paddy was dried from 30%MC down to 21% in 3 minutes; with the second-stage drying down to 14.5%, the milling quality is comparable to that in other good flat-bed dryers. However, due to its high initial investment (US$12000 for the 4-ton/hr STS-4), the promotion among the rice processors was not successful.. In 2001, a second unit adopted/modified by the Long-An Food Company was equally successful in terms of technical performance, but not used to the needed economic profit.

Figure 5: The STS-1 fluidised-bed dryer (1-ton/hour for paddy)

The in-store dryer

The technique follows the practice in Australia, with modifications to fit the humid climate in Vietnam. Pre-died paddy with maximum moisture content of 18% is slowly dried (usually in 3- 4 days) down to 14%, using ambient air, or air slightly heated to 2- 5 ^{o}C above ambient temperature. The final moisture content is uniform within 1% even with a large bin of 100 tons. The paddy is stored in the same bin, with weekly aeration to keep the MC under 14%. Thus for 6 months in storage, the seed germination quality is ensured; and for 11 months, the commercial milling quality is preserved.

The first 80-ton in-store dryer was installed and tested at Song-Hau Farm in 1995. Two other units of 100 ton capacity have been installed in Can-Tho and Binh-Dinh Provinces. One unit of 400 ton capacity have been installed An-Giang Province in 1997 (Fig.6); in the past 5 years, this equipment has dried in storage some thousands tons of paddy for seed., following the 1st stage drying by flat-bed dryers. These take advantage and complement each other: flat-bed dryer for "fast" drying, and in-store dryer for maximum uniformity in grain moisture content.

Figurer 6: The 400-ton in-store dryer at An-Giang Seed Center (lower floor)

The SRA dryer (reversible-air dryer)

The SHG-4 & SHG-8 dryers have been widely accepted due to the fairly high capacity, good grain quality (including seed), low drying cost, easy to install and operate. Still, as Vietnamese economy develops, the mechanization of drying operation should also upgraded.

For new demands of lowering the labor cost in mixing the grain, of reducing the land space, and of drying high-moisture crops (coffee, sliced cassava...), a new series of flat-bed dryers has been designed and successfully applied. This new series of dryers (with capacity ranging from 1 to 12 ton/batch) is named RA as abbreviation for Reversible Air. For example, SRA-10 means the dryer with reversible air and of 10 tons /batch capacity.

The principle, construction, and operation of the RA dryers is similar to that of the current SHG4 dryer; the only difference lies in the reversibility of the drying air (Fig.7).

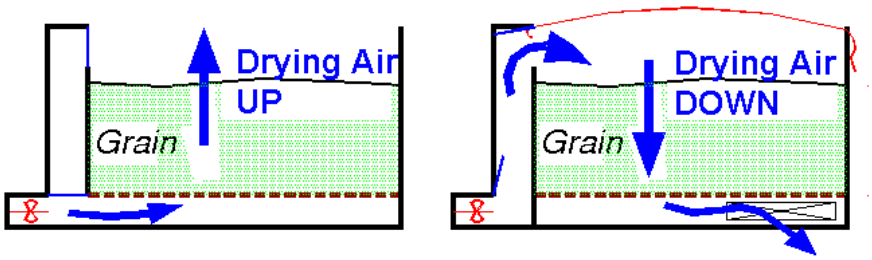

Figure 7: Principle of the reversible-air dryer

In summary, the comparative advantages of the new dryers are:

- NO MANUAL MIXING AND TURNING, yet the final moisture content is uniform.
- SAVING OF LAND SPACE, only 1/2 of the area is required compared to conventional flat-bed dryer
- MULTICROP USE, including hi-moisture products such as coffee, sliced cassava, shrimp head, longan...

This research program has been jointly supported by the Vietnamese Ministry of Science and Technology, and the Ministry of Education.

In 2000- 2003, twenty five SRA units (with capacities ranging from 2 to 12 ton/batch) have been installed at the Provinces of Long-An, Tien-Giang, Kien-Giang, An-Giang, Ca-Mau, Tay-Ninh, Dong-Nai, Ba-Ria, Dak-Lak... Some have dried over 1000 tons of paddy, or corn, or coffee. Further promotion are being done at other Provinces (Fig.8).

Figure 8: The SRA-8 Dryer

Publication as an extension activity

Publication has been considered by the Drying Research Group as an effective mean to spread the research achievements to the final user. While serving the needs of farmers and processors for their profits, our researchers get the benefit from users' feedback, so that continuous improvement can be carried out for more quality and less cost. While we freely share our research results to mechanical manufacturers, we still keep the front cutting-edge in appropriate drying equipment thanks to the never-ending research-and-extension circle. Publications (both local and oversea) has proved to be effective in promoting the above circle: Papers and conference proceedings, journal articles, news in Popular Science Magazine (KHOA HOC PHO THONG), and in particular, a book published in 2000 with 1000 copies, (Figure 9), which included all UAF drying research thus far. A list of publications is in the Bibliography.

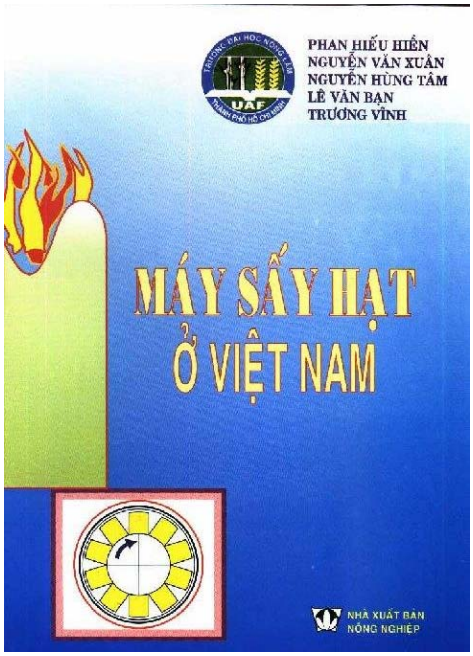

*Figure 9: Cover of the drying book (size 19 * 17cm; 120 pages)*

Concluding remark

Drying research and extension at the Nong-Lam University have been active in both

quantity and quality. Demands from the production sector are continuing with even more pressure. Together, the Faculty of Agricultural Engineering and Technology, and the Center for Agricultural Energy and Machinery of NLU will continue to offer appropriate and effective solutions to farmers and processors, with supports from various agencies, Provincial and Central, local and international, and from farmers and processors themselves.

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