Extension Outreach: Improving Vegetable Handling and Storage Systems in Russia

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Additional index words. carrot, *Daucus carota*, cooling, VOCA, USAID

Summary. Through an agency called Volunteers for Overseas Cooperative Assistance (VOCA), funded primarily by the U.S. Agency for International Development (USAID), professionals from many disciplines are recruited to assist less-developed countries (LDCs) with establishing new industries and/or improving management practices in existing businesses. We were recruited to evaluate the causes of postharvest losses of horticultural products in Russia. These losses historically have been high due to the limited availability of mechanical refrigeration and poor postharvest management practices. This paper reports on the success of an extension demonstration project in Russia where traditional storage and handling systems for carrots were compared to systems using improvements in grading and prestorage sanitation. An evaluation of storage facilities and recommendations for improvements are discussed.

The struggle with the transition from a communist economy to free enterprise is obvious in the heart of Russia. The agricultural industry is faced with a unique set of problems as public officials and managers attempt to reorganize state farms into privately owned joint stock companies. For vegetable producers, reduction of postharvest losses is essential to achieve profitability in this important segment of the industry. Further, there is a critical need to extend the quality storage life of vegetables to supply the needs of the public during the entire year. This will require investment in suitable storage facilities and implementation of basic, efficient recommended management practices in all handling operations.

Historically, the small private farms and gardens have used vegetables and other perishables more efficiently than the larger state farms (Smith, 1976, 1990). Many obstacles, including psychological and sociological factors, have been identified in LDCs that limit their ability to handle horticultural products effectively on a large scale and thus limit access to diverse and nutritional resources (Grierson, 1991; Kader, 1996; Rushing, 1996). Countries with well-developed perishable-handling systems can assist Russia by transferring existing information and appropriate technology to newly formed joint stock companies. Land grant universities in the United States are in a position to provide this invaluable assistance.

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Table 1. Percent decay of carrots stored in two warehouses designated as town site (A) and a farm site (B). Carrots were placed in storage on 20 Sept. 1995. Improved handling indicates that carrots were graded and treated with chlorine solutions. Standard handling refers to ungraded carrots without chlorine treatment. Pyramids refers to the practice of alternating layers of soil and carrots. The storage period began on 20 Sept. 1995.

Evaluation	Decayed carrots (%)				
	Improved handling		Standard handling		Pyramids
date	A	B	A	B	B
15 Dec. 1995	0.6	0.4	10.9	12.6	56.9
15 Jan. 1996	ND[z]	ND	>50.0[y]	>50.0[y]	>90.0[y]
27 Feb. 1996	1.3	1.4	---	---	---

[z]ND = no data collected.
[y]Estimates based on counted carrots; no weights taken.

This paper reports on a technology transfer project directed to Truzhennik Farm near Krasnokamsk town in the Perm Region of Russia, ≈60 miles (100 km) from the city of Perm. Krasnokamsk and Perm offer excellent vegetable marketing opportunities with their combined population of >3 million people and with good roads connecting the cities.

Truzhennik farm produces ≈1,000 acres (400 ha) of vegetables, mostly cabbage and carrots, and has the potential to supply a significant share of the region's needs for vegetables if handling methods and storage facilities can be improved sufficiently to facilitate the distribution of products in good condition during the winter. Truzhennik has large, sturdy storehouses that can accommodate the produce, but few are equipped with mechanical refrigeration for temperature control and there are no humidity control systems. They have ventilation systems consisting of fans and ducts, but these are not well maintained and operation is strictly manual. This creates opportunities for human error that have resulted in substantial losses in the past, due to either overheating or freezing of the product. We were informed that during the year before our visit, 85 tons of cabbage had been frozen in one storeroom because no one turned off the ventilation fans after the onset of subfreezing weather. Workers informed us that such disastrous losses are considered routine.

The company also has good mechanical harvesters and a packingline for carrots, but all of the equipment needs some adjustment and repair. There are many points on the packingline that cause excessive abrasion and bruises to the product. Workers include young students from a local school who are assisted by military personnel when necessary. The workers lack expertise and familiarity with the operation, which results in much unnecessary damage to the vegetables. Another major management problem is the lack of incentive for workers to do a good job. Good performance is not rewarded and poor performance is not punished. This is a serious limitation for efficient management of the company.

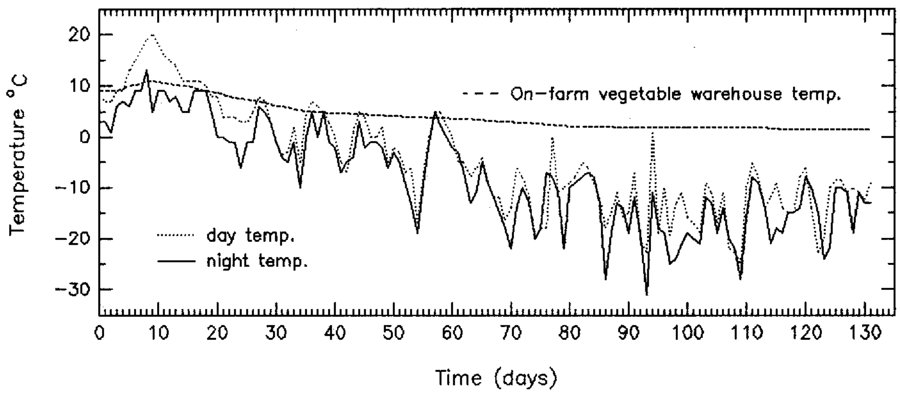
Due to the problems described above, the farm typically loses ≥75% of the vegetables that are held for long-term storage. We wanted to demonstrate to management that they can significantly improve the storability of produce without adding substantial cost if they implement appropriate postharvest handling practices that are already known to the industry in the United States and the rest of the developed world. Lack of investment capital in Russia is a serious challenge, but we believed that they could make great strides in profitability by adopting a few basic protocols that are within their means.

Carrot handling and storage demonstration

Carrot harvest. On 5 Sept. 1995, the first harvest of ≈140 t of carrots was completed using a mechanical harvester imported from Germany. Day maximum temperatures during harvest were ≈75 to 79 °F (24 to 26 °C). These carrots were in the storeroom when J. Rushing arrived in Russia on 20 Sept.

The second mechanical harvest of carrots was begun 19 Sept. 1995 and was ongoing during our first visit to the field on 21 Sept. Day maximum temperature had fallen to ≈54 °F (12 °C). The harvest would continue for ≈3 weeks.

Routine storage protocol. Carrots from the 5 Sept. harvest were placed in a conventional storeroom, ≈125 ft (38 m) long × 59 ft (18 m) wide × 20 ft (6 m) tall. The carrots were piled on the floor to a depth of ≈6.5 ft (2 m). There was no mechanical refrigeration in the storeroom; however, there was a forced-air ventilation system that used large fans to move outside air through ducts in the floor and force the air through the piles of carrots. A careful examination of the ventilation system revealed that many of the ducts were blocked and most of the air was short-circuited around, rather than through, the pile of carrots. There was no temperature control and no monitoring of carrot core temperatures during this critical period when the field heat



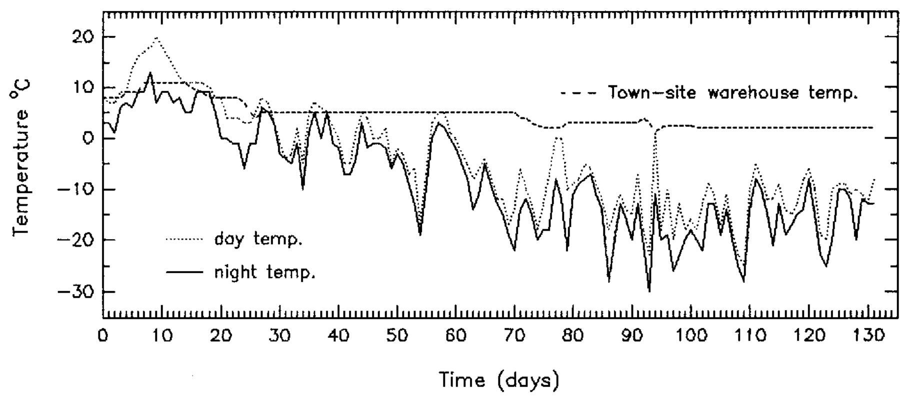


Fig. 1. Storehouse air temperature and outdoor day maximum and night minimum temperature during the carrot storage trial. Day 0 indicates the beginning of the storage trial on 20 Sept. 1995.

needed to be removed as quickly as possible.

PRESTORAGE TREATMENTS. Carrots from the 19 Sept. harvest were used to set up the prestorage treatments. The control treatment, which has been recommended in several publications directed to LDCs (Burden and Wills, 1989; Gac et al., 1984), was a traditional method of placing a layer of field-run, ungraded carrots on the storeroom floor in a square configuration, each side of the square being ≈5 ft (1.5 m). The first layer was ≈10 inches (25 cm) in height. A 10-inch (25-cm) layer of soil was placed on the layer of carrots, then another layer of carrots was placed on the soil. This procedure was repeated until a pyramid ≈5 ft (1.5 m) tall was constructed with alternating layers of carrots and soil. Upon completion of the pyramid, no carrots were visible. They were completely covered with soil.

In a second treatment, ungraded carrots were placed in ventilated metal bins with no additional handling. Each bin contained ≈770 lb (350 kg) of carrots. The bins were then placed in the storeroom beside the pyramids.

A third treatment involved grading the carrots to remove damaged and broken roots. About 40% of the carrots were unfit for storage and were set aside for immediate sale. The remaining sound roots of best quality were immersed in a solution of chlorinated water (500 ppm) for 3 to 5 min. The carrots were removed from this water and immersed in a second container of chlorinated water (500 ppm) for another 5-min treatment. Then the roots were removed from the chlorine solution and carefully placed in bins as described above. These bins were placed in the storeroom with the other bins and pyramids. All bins were covered with black plastic to exclude light.

The protocol using bins was repeated in two different storehouses. One store was on the farm near the field and the other was ≈15 miles (25 km) away in the town of Krasnokamsk. The construction of soil and carrot pyramids was done only at the farm warehouse.

Results and discussion

STORAGE EVALUATION OF THE EARLY HARVEST CARROTS. Carrots that had been harvested on 5 Sept. 1995 had virtually 100% decay when they were examined on 18 Sept., <2 weeks after harvest. The poor storage potential of the roots may be attributed to the relatively high temperature during harvest, the failure to grade and remove damaged roots, poor performance of the forced-air ventilation system, and the lack of mechanical refrigeration in the storeroom. In total, 140 t of carrots were completely unmarketable because of poor postharvest management. Workers attempted to sort ≈4 t of the decayed mass in search of any sound carrots, but no marketable roots were found.

INFLUENCE OF PRESTORAGE TREATMENTS ON STORAGE QUALITY. On 15 Dec., roots from the 19 Sept. harvest were examined. The quality of carrots from two pyramids and two bins of each of the treatments was evaluated. The only criterion that was measured quantitatively was incidence of decay. Sound carrots were separated from decayed carrots and the two lots were weighed. Decay is expressed as a percentage of the initial weight taken at the beginning of storage. Carrots from pyramids at the farm warehouse had 56.9% decay. Ungraded, unchlorinated carrots stored in bins had 12.6% decay, compared to 0.4% decay in carrots that had been graded and treated with chlorinated water (Table 1).

At the town-site warehouse where only bins were used for storage, the ungraded, unchlorinated carrots had 10.9% decay compared to only 0.6% decay in roots that had been graded and treated with chlorinated water (Table 1).

In mid-January 1996, a cursory examination of carrots in pyramids revealed that decay was >90%. The few remaining sound carrots were sorted and sold. Likewise, ungraded, unchlorinated carrots in bins had >50% decay (Table 1). These roots also were sorted and the sound carrots were sold because local supplies in the city were exhausted.

Carrots that had been carefully graded and chlorinated were in very good condition and were returned to storage until 27 Feb. 1996. On this date, a final quality examination was conducted. Roots stored at the farm site had 1.4% decay and roots at the town-site had 1.3% decay (Table 1). Carrots were stored for >5 months with minimal deterioration simply by using techniques that could easily be incorporated into existing management protocol at minimal cost.

Conclusions

In the Perm Region of Russia, ambient temperature extremes compound the problems of excessive harvest injury, the lack of mechanical refrigeration, and poor management of ventilation systems in vegetable storehouses. Early in the harvest period, day temperatures can be high enough to promote rapid decay of the product (Fig. 1). During the same period, temperatures can fall below freezing, and if ventilation systems are not properly attended severe freezing injury to the vegetables can occur. Automated control of ventilation systems could allow storage operators to take advantage of cold ambient temperatures to remove field heat and minimize the risk of freezing vegetables, which has occurred in the past with manual fan operation.

Contact was maintained with vegetable storehouse managers during the 1997 season through the VOCA office in Moscow. Although the managers reported that funds had been designated for making the improvements that we recommended, budget constraints ultimately precluded the implementation of any changes in 1997.

Improvements in postharvest management practices, particularly grading out damaged roots, applying chlorine treatments, and using bins for storage, can help reduce decay and significantly increase the storage life of the carrots as demonstrated in this study. Installing modern equipment for temperature control is essential to achieve a long-term solution to the problems that exist in Russia and other LDCs, but better management of existing facilities can dramatically improve the quality and shelf life of vegetables, enhance profitability for producers, and ensure that consumers have an adequate supply of nutritional food for a much longer period of time than they currently have. Researchers and extension specialists in the U.S. land grant university system can be an invaluable resource for the transfer of this technology.

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