Ontario

Rutabaga

5.0 Rutabaga Food Safety Risk Assessment

Food Inspection Branch
Food Industry Division
Ontario Ministry of Agriculture and Food

Activity	Hazard/ Concern	Risk Characterization		
		Probability (Likelihood of Going Wrong)		
		of contamination	of consumer exposure	of secondary spread among humans
Pre-Production ***Site Selection and Preparation*** This includes application of soil amendments such as manure, biosolids and chemical fertilizer, prior to planting the rutabaga crop.	**Biological** Concern that pathogens in the soil and soil amendments could contaminate the future rutabaga crop (2, and 7). See Appendix B for a list of pathogens known to contaminate produce.	Nglg-Low Although the possibility of contamination exists, microbial and environmental degradation of pathogens over time reduces the likelihood of contaminating the crop (15). One study indicates that in the presence of pathogens, potential for infiltration, survival and growth of pathogens in vegetables exists (7).	Nglg If contamination occurs, the probability of the pathogen surviving through to consumption is extremely low. Even if pathogens do survive, they are usually found on the outer surface of the rutabaga, which is normally washed during the trimming and packing stage, and removed prior to consumption (15).	Low Some foodborne pathogens are easily transmitted directly from person-to-person, or by the fecal to oral route. If infection occurs, secondary spread among humans can occur. While primary spread may be broadly distributed, secondary spread is expected to be local.

Risk Characterization			**Risk Summary**		**Recommendations for Action**
Impact (Consequences of Going Wrong)			**Uncertainty of Data**	**Summary of Risk and Uncertainty**	
on human health	economic	environment			
Low-High If infection occurs, the impact is variable, depending on the pathogen and individual. The young, elderly, and immune-compromised are at greater risk (40). Symptoms are variable, from mild diarrhea and upset stomach, to extreme cases where death may occur (15, and 78).	Low-Med Direct healthcare costs vary with pathogen virulence, individual vulnerability, and size of outbreak. If an outbreak is traceable to a specific company or industry, the indirect economic impact could be high (69).	Nglg Although no specific studies are known, the presence of biological hazards in food crops is considered to have negligible impact on the environment.	Low No specific hazards have been identified in rutabaga production. Although there is a lack of specific data on pre-production biological contamination, experience, knowledge of plant growth and the industry, and a lack of traceable cases provide reasonable certainty.	**Nglg** The probability of contamination is mainly negligible, and exposure from contamination at this stage of production is unlikely. The impacts of contamination are mostly low. While there is some uncertainty, the overall risk is considered negligible.	**To reduce risk:** Test soil for pathogens. Investigate previous land uses and history of the site and its adjacent sites. Only well-composted manure should be applied to the soil. Manure should be applied and incorporated into the soil the previous fall, if possible. Apply biosolids and sewage biosolids at least 12 months or more, prior to planting. This requires a permit and the Ministry of Environment (MOE) approval.

Activity	Hazard/ Concern	Risk Characterization		
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Pre-Production ***Site Selection and Preparation*** This includes application of soil amendments such as manure, biosolids and chemical fertilizer prior to planting the rutabaga crop.	**Chemical** Concern that intentionally applied products or chemicals from the environment at or near the production site will contaminate the future seed crop (40).	Nglg-Low Agricultural chemicals registered for use are routinely applied to the soil at this stage. However, the rutabaga crop is not yet present to become contaminated. It is normal during growth for plants to absorb chemicals from the environment (37). Regulations and guidelines are in place for applying chemical products to land. The probability of chemicals being present at levels higher than allowed at the time of consumption is quite low, particularly when considering the stage and the processes in place to control chemicals in water sources, air, soil, and on foods (46, and 74).	Nglg If contamination of rutabagas occurs, the probability of significant consumer exposure depends on toxicity and persistence of the chemical and length of time until consumption (39, 40, and 44). Rutabagas are normally washed and peeled before consumption.	Nglg Chemicals are not conducive to secondary spread among humans.

Risk Characterization			Risk Summary		Recommendations for Action
Impact (Consequences of Going Wrong)			**Uncertainty of Data**	**Summary of Risk and Uncertainty**	
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Nglg-Med The overall impact of chemicals on human health is generally quite low. Chemicals are very rarely found on produce in high enough concentrations to cause acute health effects. Although the effects of long-term exposure to many chemicals are not well known, there is evidence that exposure to certain chemicals over a long period of time can cause numerous health effects including cancer (35, 36, 39, 40, 41, and 42).	Low Direct healthcare costs vary with the scope of contamination. If the contaminant is traceable to a specific company or industry, the indirect economic impact may be significant (43).	Nglg At the levels at which chemicals are found in food, the impact of contaminated food on the environment would be negligible.	Low Results from the Ontario Food Safety Monitoring Program indicate a very low incidence of chemical residues exceeding the allowable Maximum Residue Limits (MRLs), as set by Health Canada (45, and 46). The lack of traceable cases provides reasonable certainty of the assessment.	**Nglg** Data for specific long-term effects are limited. Overall risk of illness from applied chemicals or those in the environment is negligible to low, due to the negligible probability of contamination and human exposure.	**To reduce risk:** Investigate previous uses of the site and its adjacent sites. Apply biosolids and sewage biosolids a minimum of 12 months prior to planting. This requires a permit and the Ministry of Environment (MOE) approval. Test soil for chemicals where the possibility of contamination exists. Follow label requirements on all chemicals applied to the rutabaga crop. Do not use chemicals that are not registered for use on rutabaga. Follow guidelines for use of biosolids as set out in OMAF fact sheet 95-069. Follow rutabaga production recommendations as set out in OMAF publication #363. Follow the seed handling instructions on the seed package and in OMAF publication #363.

Activity	Hazard/ Concern	Risk Characterization		
		Probability (Likelihood of Going Wrong)		
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Pre-Production ***Site Selection and Preparation*** This includes application of soil amendments such as manure, biosolids and chemical fertilizer prior to planting the rutabaga crop.	**Physical** Concern that extraneous physical materials such as metal, wood, rocks, glass, plastic, etc. may contaminate the future rutabaga crop. Physical hazards in food are known to cause injury (47, 48, and 49). See Appendix C for a list of physical material hazards and potential injury.	Nglg No issues have been identified. Rutabaga is not likely to incorporate extraneous material into its structure. The probability of any physical extraneous material entering the rutabaga is negligible.	Nglg If contamination occurs, the probability of consumer exposure is negligible. Rutabaga is generally washed and peeled prior to consumption, which should remove extraneous material on or near the surface.	Nglg Physical hazards are not conducive to secondary spread among humans.

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Nglg-Low If contamination occurs, the impact is variable, depending on the physical hazard and individual.	Nglg If contamination occurs and is traceable to a specific company or industry, the overall economic impact would be negligible to low, but the impact on the specific company could be significant.	Nglg The impact of any physical hazards on the environment is considered negligible.	Low No previous issues have been identified with rutabagas. Experience and knowledge of rutabaga plant growth and production provide reasonable certainty of the assessment.	**Nglg** Although the impact is variable and specific data are not known, due to the negligible probabilities of contamination and exposure, it is reasonably certain that the overall risk at pre-production is negligible.	**To reduce risk:** Keep fields free of debris. Be aware of and provide information to employees on potential physical material hazards. Use Good Agricultural Practices (GAPs) (30, and 31).

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Production ***Growing the Crop*** Application of fertilizers, crop protection materials, and other soil or crop amendments as well as irrigation water.	**Biological** Concern that pathogens such as *Listeria*, *E. coli 0157:H7*, *Cryptosporidium*, *Salmonella*, and *Hepatitis A*, may contaminate the rutabaga from water used for irrigation and spray application. Contamination may also occur from worker hygiene in the field, and bird and animal droppings during the growing stage. See Appendix B for a list of foodborne pathogens associated with produce.	Low Contamination from a number of sources during crop production is possible (122, 126, 133, 134, and 135). Water can be a carrier for pathogens (55, and 92). Recent information indicates that some pesticides may actually increase the growth of pathogens in spray tanks (61). Contamination from insects during pollination may be possible. One study indicates that in the presence of pathogens, there is some potential for infiltration, survival, and growth of pathogens in vegetables (7).	Nglg-Low If contamination occurs, the probability of the pathogen surviving through to consumption is quite low. Even if pathogens do survive, they are usually found on the outer surface of the rutabaga, which is normally washed during the trimming and packing stage and removed prior to consumption (15).	Low Some foodborne pathogens are easily transmitted directly from person-to-person, or by the fecal to oral route. If infection occurs, secondary spread among humans can occur. While primary spread may be broadly distributed, secondary spread is expected to be mainly local.

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Low-High If infection occurs, the impact is variable, depending on the pathogen and individual. The young, elderly, and immune-compromised are at greater risk (40). Symptoms are variable, from mild diarrhea and upset stomach, to extreme cases where death may occur (15, and 16).	Low-Med Direct healthcare costs vary with pathogen virulence, individual vulnerability, and size of outbreak. If an outbreak is traceable to a specific company or industry, the indirect economic impact could be high (68).	Nglg Although no specific studies are known, the presence of biological hazards in food crops is considered to have negligible impact on the environment.	Low-Med No specific hazards have been identified in rutabaga production. Although there are a lack of specific data on pre-production biological contamination, experience, knowledge of plant growth and the industry, and lack of traceable cases provide reasonable certainty of the assessment.	**Nglg-Low** The probabilities of contamination and exposure at this stage of production are quite low. The impact of contamination is mainly low. While there is some uncertainty, the overall risk is expected to be negligible to low.	**To reduce risk:** Only potable water should be used where possible. Have proper toilet and hand washing facilities in the field for workers. Irrigation water should be tested regularly for pathogens.

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Production ***Growing the Crop*** Application of fertilizer, crop protection materials, other soil or crop amendments as well as irrigation water.	**Chemical** Contamination of rutabaga with applied products such as fertilizer, herbicides, fungicides and other soil or crop amendments while growing the crop. While the level of chemicals in food is usually quite low, it has been suggested that foods are a potential source of exposure to chemicals (35, and 36).	Low-High Agricultural chemicals registered for use are routinely applied at this stage (158) and plants absorb chemicals from the environment during growth (37). Therefore the probability of contaminating the crop at this stage is considered low to high (46). However, the probability of chemicals being present at levels higher than is allowed at the time of consumption is quite low, due to processes in place to control registration, selling, storage, and use of chemicals on food (40, and 78).	Nglg If contamination of rutabagas occurs, the probability of significant consumer exposure depends on toxicity and persistence of the chemical and the length of time until consumption (39, 40, and 44). Chemicals may dissipate, degrade or be eliminated over time and through washing and peeling prior to consumption, which reduces the probability of consumer exposure.	Nglg Chemicals are not conducive to secondary spread among humans.

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Nglg-Med The overall impact of chemicals on human health is generally quite low. Chemicals are very rarely found on produce in high enough concentrations to cause acute health effects. Although the effects of long-term exposure to many chemicals are not well known, there is evidence that exposure to certain chemicals over a long period of time can cause numerous health effects including cancer (35, 36, 39, 40, 41, and 42).	Low Direct healthcare costs vary with the scope of contamination. If the contaminant is traceable to a specific company or industry, the indirect economic impact may be significant (43).	Nglg-Low At the levels at which chemicals are found in food, the impact of contaminated food on the environment would be negligible.	Low Results from the Ontario Food Safety Monitoring Program indicate a very low incidence of chemical residues exceeding the allowable Maximum Residue Limits (MRLs), as set by Health Canada (45, and 46). The lack of traceable cases provides reasonable certainty of the assessment.	**Nglg** Data for specific long-term effects are limited. Overall risk of illness from registered pesticides is negligible to low, due to the negligible probability of contamination and human exposure.	**To reduce risk:** Follow label requirements on all chemicals applied to the rutabaga crop. Do not use chemicals that are not registered for use on rutabagas. Follow guidelines for use of biosolids as set out in OMAF fact sheet 95-069. Follow rutabaga production recommendations as set out in OMAF publication #363. Follow the seed handling instructions on the seed package and in OMAF publication #363.

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Production ***Growing the Crop*** Application of fertilizer, crop protection materials, other soil or crop amendments as well as irrigation water.	**Physical** Concern that extraneous physical materials such as metal, wood, rocks, glass, plastic, etc., may contaminate the rutabaga crop. Physical hazards in food are known to cause injury (47, 48, and 49). See Appendix C for a list of physical material hazards and potential injury.	Nglg No issues have been identified. Rutabaga is not likely to incorporate extraneous material into its structure. The probability of any physical extraneous material entering the rutabaga is negligible.	Nglg If contamination occurs, the probability of consumer exposure is negligible. Rutabaga is generally washed and peeled prior to consumption, which should remove extraneous material on or near the surface.	Nglg Physical hazards are not conducive to secondary spread among humans.

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Nglg If contamination occurs, the impact is variable, depending on the physical hazard and individual.	Nglg If contamination occurs and is traceable to a specific company or industry, the economic impact would be low.	Nglg The impact of any physical hazards on the environment is considered negligible.	Low No previous issues have been identified with rutabagas. Experience and knowledge of rutabaga plant growth and production provide reasonable certainty of the assessment.	**Nglg** Although the impact is variable and specific data are not known, due to the negligible probabilities of contamination and exposure, it is reasonably certain that the overall risk at pre-production is negligible.	**To reduce risk:** Keep fields free of debris. Be aware of and provide information to employees on potential physical material hazards. Use Good Agricultural Practices (GAPs) (30, and 31).

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Production ***Harvesting*** Rutabagas are mechanically harvested and placed into large bins for transport.	**Biological** Concern that containers and harvesting equipment exposed to soil, bird, and animal feces may contaminate rutabagas.	Nglg-Low Although contamination of produce at harvest may occur, contamination of plant tissue is largely associated with the outer surface. The inner tissue of sound produce is considered sterile (15). Since rutabagas are mechanically harvested, there is little contact by humans.	Nglg-Low If contamination occurs, the probability of the pathogen surviving through to consumption is low. Even if pathogens do survive, they are usually found on the outer surface of the rutabaga, which is normally washed during the trimming and packing stage and removed prior to consumption (15).	Low Some foodborne pathogens are easily transmitted directly from person-to-person, or by the fecal to oral route. If infection occurs, secondary spread among humans can occur. While primary spread may be broadly distributed, secondary spread is expected to be mainly local.

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Low-High If infection occurs, the impact is variable, depending on the pathogen and individual. The young, elderly, and immune-compromised are at greater risk (40). Symptoms are variable, from mild diarrhea and upset stomach, to extreme cases where death may occur (15, and 78).	Low-Med Direct healthcare costs vary with pathogen virulence, individual vulnerability, and size of outbreak. If an outbreak is traceable to a specific company or industry, the indirect economic impact could be high (68).	Nglg Although no specific studies are known, the presence of biological hazards in food crops is considered to have negligible impact on the environment.	Low No specific hazards have been identified in rutabaga production. Although there are a lack of specific data on pre-production biological contamination, experience, knowledge of plant growth and the industry, and lack of traceable cases provide reasonable certainty of the assessment.	**Nglg-Low** The probabilities of contamination and exposure at this stage of production are quite low. The impacts of contamination are mostly low. While there is some uncertainty, the overall risk is expected to be negligible to low.	**To reduce risk:** Have proper toilet and hand washing facilities available for workers in the field. Ensure that harvesting equipment and all containers are clean and free from animal and bird feces.

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Production ***Harvesting*** *Rutabagas are mechanically harvested and placed into large bins for transport.*	**Chemical** Concern that rutabagas may become contaminated with chemicals during harvest. While the level of chemicals in food is quite low, it has been suggested that foods are a source of exposure to chemicals (35, and 36).	Nglg Chemicals are not deliberately applied to rutabagas during this stage. Lubricants from harvest machinery may cause contamination, but the likelihood of this occurring is extremely low. The probability of chemically contaminating the rutabagas at this stage is negligible.	Nglg If contamination of rutabagas occurs, the probability of significant consumer exposure depends on toxicity and persistence of the chemical and the individual exposed (39, 40, and 44). Rutabagas are normally washed and peeled before consumption. The length of time between harvesting and consumption also acts to reduce the probability of consumer exposure.	Nglg Chemicals are not conducive to secondary spread among humans.

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Nglg-Med The overall impact of chemicals on human health is generally quite low. Chemicals are very rarely found on produce in high enough concentrations to cause acute health effects. Although the effects of long-term exposure to many chemicals are not well known, there is evidence that exposure to certain chemicals over a long period of time can cause numerous health effects including cancer (35, 36, 39, 40, 41, and 42).	Low Direct healthcare costs vary with the scope of contamination. If the contaminant is traceable to a specific company or industry, the indirect economic impact may be significant (43).	Nglg At the levels at which chemicals are found in food, the impact of contaminated food on the environment would be negligible.	Low Results from the Ontario Food Safety Monitoring Program indicate a very low incidence of chemical residues exceeding the allowable Maximum Residue Limits (MRLs), as set by Health Canada (45, and 46). The lack of traceable cases provides reasonable certainty of the assessment.	**Nglg** Data for specific long-term effects are limited. Overall risk of illness from registered pesticides is negligible to low, due to the negligible probability of contamination and human exposure.	**To reduce risk:** Ensure containers have not been used for storing chemicals. Investigate the source of the containers and what materials were used in manufacturing the containers. Ensure that all machinery is well maintained and that there is no leaking of lubricants.

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Production ***Harvesting*** Rutabagas are mechanically harvested and placed into large bins for transport.	**Physical** Concern that extraneous physical materials such as metal, wood, rocks, glass, plastic, etc., may contaminate the rutabaga. Physical hazards in food are known to cause injury (47, 48, and 49). See Appendix C for a list of physical material hazards and potential injury.	Nglg No issues have been identified. Rutabaga is not likely to incorporate extraneous material into its structure. The probability of any physical extraneous material entering the rutabaga is negligible.	Nglg If contamination occurs, the probability of consumer exposure is negligible. Rutabaga is generally washed and peeled prior to consumption, which should remove extraneous material on or near the surface.	Nglg Physical hazards are not conducive to secondary spread among humans.

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Nglg If contamination occurs, the impact is variable, depending on the physical hazard and individual.	Nglg If contamination occurs and is traceable to an individual company or industry, the economic impact would be low.	Nglg The impact of any physical hazards on the environment is considered negligible.	Low No previous issues have been identified with rutabagas. Experience and knowledge of rutabaga plant growth and production provide reasonable certainty of the assessment.	**Nglg** Although the impact is variable and specific data are not known, due to the negligible probabilities of contamination and exposure, it is reasonably certain that the overall risk at pre-production is negligible.	**To reduce risk:** Use only sound containers for harvesting and packing rutabaga. Be aware of and provide information to employees on potential physical material hazards. Use Good Agricultural Practices GAPs (30, and 31).

Activity	Hazard/ Concern	Risk Characterization		
		Probability (Likelihood of Going Wrong)		
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Post Harvest ***Storage*** Rutabagas are held in storage in large containers before washing trimming and packing.	**Biological** Concern that pathogens absorbed by rutabaga from rodent and animal droppings may cause contamination. Rutabaga stored where storage temperatures are too high, allowing pathogens to multiply.	Nglg Foodborne pathogens can be transmitted in storage through feces. There is some potential for pests to have contact with rutabaga in storage (15). Packing rutabagas in containers may limit contact with pests and other sources of pathogens and reduces contamination.	Nglg-Low If contamination occurs, the probability of the pathogen surviving through to consumption is low. Even if pathogens do survive, they are usually found on the outer surface of the rutabaga, which is normally washed during the trimming and packing stage and removed prior to consumption (15).	Low Some foodborne pathogens are easily transmitted directly from person-to-person, or by the fecal to oral route. If infection occurs, secondary spread among humans can occur. While primary spread may be broadly distributed, secondary spread is expected to be mainly local.

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Low-High If infection occurs, the impact is variable, depending on the pathogen and individual. The young, elderly, and immune-compromised are at greater risk (40). Symptoms are variable, from mild diarrhea and upset stomach, to extreme cases where death may occur (15, and 78).	Low-Med Direct healthcare costs vary with pathogen virulence, individual vulnerability, and size of outbreak. If an outbreak is traceable to a specific company or industry, the indirect economic impact could be high (68).	Nglg Although no specific studies are known, the presence of biological hazards in food crops is considered to have negligible impact on the environment.	Low-Med No previous biological hazards attributed to rutabaga during this stage have been identified. Experience, knowledge of plant growth and the industry, and lack of traceable cases provide reasonable certainty of the assessment.	**Nglg-Low** The probabilities of contamination and exposure are very low. The impact of contamination is mostly low. While there is some uncertainty, the overall risk is expected to be quite low.	**To reduce risk:** Ensure storage areas are free from animals and rodents. Bait stations should be monitored and maintained. Wash and sanitize storage room before rutabagas are brought into the room. Follow temperature recommendations as set out on Page #29 in the Vegetable Production Recommendations Publication #363.

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Post Harvest ***Storage*** Rutabagas are held in storage in large containers before washing trimming and packing.	**Chemical** Chemical contamination from climate control equipment (leaks in the system). Contamination from cleaners, disinfectants or sanitizers. Agricultural chemicals stored near the storage room. While the level of chemicals in food is quite low, it has been suggested that foods are sources of exposure to chemicals (35, and 36).	Nglg Chemicals are not intentionally applied to rutabagas during this stage. Chemicals from cooling machinery may cause contamination, but the likelihood of this occurring is extremely low. The probability of chemical contamination of the rutabaga at this stage is considered negligible.	Nglg-Low If contamination occurs, the probability of consumer exposure is very low, as most chemicals will be found on the outer surface of rutabaga. These surfaces can be washed and/or removed prior to consumption.	Nglg Chemicals are not conducive to secondary spread among humans.

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Nglg-Med The overall impact of chemicals on human health is generally quite low. Chemicals are very rarely found on produce in high enough concentrations to cause acute health effects. Although the effects of long-term exposure to many chemicals are not well known, there is evidence that exposure to certain chemicals over a long period of time can cause numerous health effects including cancer (35, 36, 39, 40, 41, and 42).	Low Direct healthcare costs vary with the scope of contamination. If the contaminant is traceable to a specific company or industry, the indirect economic impact may be significant (43).	Nglg At the levels at which chemicals are found in food, the impact of contaminated food on the environment would be negligible.	Low No previous issues have been identified at this stage of production. The lack of traceable cases provides some certainty of the assessment.	**Nglg** Overall risk from chemicals at this stage is negligible to low, due to the negligible probability of contamination and human exposure.	**To reduce risk:** Keep chemicals away from the rutabaga storage area, preferably in a separate building. Keep climate control equipment in good operating condition. Ensure that any cleaning, sanitizing, and disinfectant compounds are used in accordance with package directions.

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Post Harvest ***Storage*** Rutabagas are held in storage in large containers before washing trimming and packing.	**Physical** Concern that extraneous physical materials such as metal, wood, rocks, glass, plastic, etc., may contaminate the rutabaga. Physical hazards in food are known to cause injury (47, 48, and 49). See Appendix C for a list of physical material hazards and potential injury.	Nglg No issues have been identified. Rutabaga is not likely to incorporate extraneous material into its structure. The probability of any physical extraneous material entering the rutabaga is negligible.	Nglg If contamination occurs, the probability of consumer exposure is negligible. Rutabaga is generally washed and peeled prior to consumption, which should remove extraneous material on or near the surface.	Nglg Physical hazards are not conducive to secondary spread among humans.

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Nglg If contamination occurs, the impact is variable, depending on the physical hazard and individual.	Nglg If contamination occurs and is traceable to a specific company or industry, the economic impact would be quite low.	Nglg The impact of physical hazards in any food crop on the environment is considered negligible.	Low No previous issues have been identified with rutabagas. Experience and knowledge of rutabaga production provide reasonable certainty of the assessment.	**Nglg** Although the impact is variable and specific data are limited, due to the negligible probabilities of contamination and exposure, it is reasonably certain that the overall risk is negligible.	**To reduce risk:** Be aware of and provide information to employees on potential physical material hazards. Use Good Agricultural Practices GAPs (30, and 31)

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Post Harvest ***Washing, Trimming, and Packing*** Rutabagas are washed, the crown and root are trimmed off by hand and they are then packed into 50-pound crates for transport.	**Biological** Worker hygiene. Contaminated wash water. Rodent and animal droppings. Cleanliness of packing area and packing equipment. Cleanliness of containers.	Low Workers will likely have contact with the rutabagas during this stage and studies have shown that people can contaminate produce (31, 50, 65, and 105). Contaminated water, equipment and containers can also be a source of contamination of the rutabagas.	Low If contamination occurs at this stage in the process, after or during washing, the probability of consumer exposure is low. Even though the rutabaga might not be subjected to any further washing, pathogens are usually found on the outer surface of the rutabaga, which is normally removed prior to consumption (15).	Low Some foodborne pathogens are easily transmitted directly from person-to-person, or by the fecal to oral route. If infection occurs, secondary spread among humans can occur. While primary spread may be broadly distributed, secondary spread is expected to be mainly local.

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Low-High If infection occurs, the impact is variable, depending on the pathogen and individual. The young, elderly, and immune-compromised are at greater risk (40). Symptoms are variable, from mild diarrhea and upset stomach, to extreme cases where death may occur (15, and 78).	Low-Med Direct healthcare costs vary with pathogen virulence, individual vulnerability, and size of outbreak. If an outbreak is traceable to a specific company or industry, the indirect economic impact could be high (68).	Nglg Although no specific studies are known, the presence of biological hazards in food crops is considered to have negligible impact on the environment.	Low-Med Experience, knowledge of plant growth and industry, and lack of traceable cases provide reasonable certainty of the assessment.	**Nglg-Low** The probabilities of contamination and exposure are very low. The impact of contamination is mainly low. While there is some uncertainty, the overall risk is expected to be quite low.	**To reduce risk:** Keep the packing room clean at all times. Have proper toilet and washing facilities available for workers. Use clean containers.

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Post Harvest ***Washing, Trimming, and Packing*** Rutabagas are washed, the crown and root are trimmed off by hand and they are then packed into 50-pound crates for transport.	**Chemical** Chemicals from the packing facility contaminating the rutabagas. Contamination from cleaners, disinfectants, or sanitizers. Wax is applied to the rutabaga for protection. While the level of chemicals in food is quite low, it has been suggested that foods are sources of exposure to chemicals (35, and 36).	Nglg Chemicals are not intentionally applied to rutabagas during this stage. Chemicals from cooling machinery or sanitation chemicals may cause contamination, but the likelihood of this occurring is extremely low. The probability of chemically contaminating the rutabaga at this stage is considered negligible.	Nglg-Low If contamination occurs, the probability of consumer exposure to chemicals is very low, as most chemicals will be found on the outer surface of rutabaga. These surfaces can be washed and/or removed prior to consumption.	Nglg Chemicals are not conducive to secondary spread among humans.

Risk Characterization			Risk Summary		Recommendations for Action
Impact (Consequences of Going Wrong)			**Uncertainty of Data**	**Summary of Risk and Uncertainty**	
on human health	economic	environment			
Nglg-Med The overall impact of chemicals on human health is generally quite low. Chemicals are very rarely found on produce in high enough concentrations to cause acute health effects. Although the effects of long-term exposure to many chemicals are not well known, there is evidence that exposure to certain chemicals over a long period of time can cause numerous health effects including cancer (35, 36, 39, 40, 41, and 42).	Low Direct healthcare costs vary with the scope of contamination. If the contaminant is traceable to a specific company or industry, the indirect economic impact may be significant (43).	Nglg At the levels at which chemicals are found in food, the impact of contaminated food on the environment would be negligible.	Low No previous issues have been identified at this stage of production. The lack of traceable cases provides some certainty of the assessment.	**Nglg** Data for specific long-term effects are limited. Overall risk of illness from registered pesticides is negligible to low, due to the negligible probability of contamination and human exposure.	**To reduce risk:** Ensure that cleaning, sanitizing, and disinfectant compounds are used in accordance with package directions. Only use wax that is approved for use on edible products and apply wax according to the manufacturer's recommendations.

Activity	Hazard/ Concern	Risk Characterization		
		Probability (Likelihood of Going Wrong)		
		of contamination	of consumer exposure	of secondary spread among humans
Post Harvest ***Washing, Trimming, and Packing*** Rutabagas are washed, the crown and root are trimmed off by hand and they are then packed into 50-pound crates for transport.	**Physical** Concern that extraneous physical materials such as metal, wood, rocks, glass, plastic, etc., may contaminate the rutabaga. Physical hazards in food are known to cause injury (47, 48, and 49). See Appendix C for a list of physical material hazards and potential injury.	Nglg No issues have been identified. Rutabaga is not likely to incorporate extraneous material into its structure. The probability of any physical extraneous material entering the rutabaga is negligible.	Nglg If contamination occurs, the probability of consumer exposure is negligible. Rutabaga is generally washed and peeled prior to consumption, which should remove extraneous material on or near the surface.	Nglg The nature of the physical hazard is not conducive to secondary spread among humans.

Risk Characterization			**Risk Summary**		**Recommendations for Action**
Impact (Consequences of Going Wrong)			**Uncertainty of Data**	**Summary of Risk and Uncertainty**	
on human health	economic	environment			
Nglg If contamination occurs, the impact is variable, depending on the physical hazard and individual.	Nglg If contamination occurs and is traceable to a specific company or industry, the economic impact would be quite low.	Nglg The impact of physical hazards in any food crop on the environment is considered negligible.	Low No previous issues have been identified with rutabagas. Experience and knowledge of rutabaga production provide reasonable certainty of the assessment.	**Nglg** Although the impact is variable and specific data are not known, due to the negligible probabilities of contamination and exposure, it is reasonably certain that the overall risk at pre-production is negligible.	**To reduce risk:** Keep packing room and equipment clean and dispose of debris on a regular basis.

Activity	Hazard/ Concern	Risk Characterization		
		Probability (Likelihood of Going Wrong)		
		of contamination	of consumer exposure	of secondary spread among humans
Post Harvest ***Transportation, Warehousing and Distribution*** 50-pound crates of rutabagas are loaded onto trucks and transported to warehouses for distribution to retail stores.	**Biological** Worker hygiene. Rodent and animal droppings. Cleanliness of distribution facility and their equipment. Proper climate control during transportation and distribution. Cleanliness of transportation vehicle.	Nglg-Low At this stage rutabagas are in containers, which limits the contact with humans and other sources of pathogens. Temperature abuse during this stage can lead to favourable conditions for pathogen growth.	Low If contamination occurs at this stage in the process, the probability of consumer exposure is low. Even though the rutabaga might not be subjected to any further washing, pathogens are usually found on the outer surface of the rutabaga, which is normally removed prior to consumption (15).	Low Some foodborne pathogens are easily transmitted directly from person-to-person, or by the fecal to oral route. If infection occurs, secondary spread among humans can occur. While primary spread may be broadly distributed, secondary spread is expected to be mainly local.

Risk Characterization			Risk Summary		Recommendations for Action
Impact (Consequences of Going Wrong)			**Uncertainty of Data**	**Summary of Risk and Uncertainty**	
on human health	economic	environment			
Low-High If infection occurs, the impact is variable, depending on the pathogen and individual. The young, elderly, and immune-compromised are at greater risk (40). Symptoms are variable, from mild diarrhea and upset stomach, to extreme cases where death may occur (15, and 78).	Low-Med Direct healthcare costs vary with pathogen virulence, individual vulnerability, and size of outbreak. If an outbreak is traceable to a specific company or industry, the indirect economic impact could be high (68).	Nglg Although no specific studies are known, the presence of biological hazards in food crops is considered to have negligible impact on the environment.	Low-Med No previous biological hazards attributed to rutabaga during this stage have been identified. Experience, knowledge of plant growth and the industry, and lack of traceable cases provide reasonable certainty of the assessment.	**Nglg** The probabilities of contamination and exposure are very low. The impact of contamination is mostly low. While there is some uncertainty, the overall risk is expected to be quite low.	**To reduce risk:** Have proper toilet and washing facilities available for workers. Maintain rutabaga at proper temperature during transportation, warehousing and distribution. Monitor and maintain rodent bait stations regularly. Keep transportation vehicles clean and sanitized.

Activity	Hazard/ Concern	Risk Characterization		
		Probability (Likelihood of Going Wrong)		
		of contamination	of consumer exposure	of secondary spread among humans
Post Harvest ***Transportation, Warehousing and Distribution*** 50-pound crates of rutabagas are loaded onto trucks and transported to warehouses for distribution to retail stores.	Chemical Chemical contamination of rutabaga from climate control equipment, cleaners, sanitizers or disinfectants. Chemical residues in transportation equipment. While the level of chemicals in food is quite low, it has been suggested that foods are sources of exposure to chemicals (35, and 36).	Nglg Chemicals are not intentionally applied to rutabagas during this stage. Chemicals from cooling machinery or sanitation chemicals may cause contamination, but the likelihood of this occurring is extremely low. The probability of chemical contamination of the rutabaga at this stage is considered negligible.	Nglg-Low If contamination occurs, the probability of consumer exposure to chemicals is very low, as most chemicals will be found on the outer surfaces of rutabagas. These surfaces can be washed and/or removed prior to consumption.	Nglg Chemicals are not conducive to secondary spread among humans.

Risk Characterization			Risk Summary		Recommendations for Action
Impact (Consequences of Going Wrong)			**Uncertainty of Data**	**Summary of Risk and Uncertainty**	
on human health	economic	environment			
Nglg-Med The overall impact of chemicals on human health is generally quite low. Chemicals are very rarely found on produce in high enough concentrations to cause acute health effects. Although the effects of long-term exposure to many chemicals are not well known, there is evidence that exposure to certain chemicals over a long period of time can cause numerous health effects including cancer (35, 36, 39, 40, 41, and 42).	Low Direct healthcare costs vary with the scope of contamination. If the contaminant is traceable to a specific company or industry, the indirect economic impact may be significant (43).	Nglg At the levels at which chemicals are found in food, the impact of contaminated food on the environment would be negligible.	Low No previous issues have been identified at this stage of production. The lack of traceable cases provides some certainty of the assessment.	**Nglg** Data for specific long-term effects are limited. Overall risk of illness from registered pesticides is negligible to low, due to the negligible probability of contamination and human exposure.	**To reduce risk:** Keep rutabaga transporting vehicles clean and sanitized. Do not use a vehicle which has previously transported chemicals. Keep climate control equipment in good working order. Ensure that any cleaning, sanitizing, and disinfectant compounds are used in accordance with package directions.

Activity	Hazard/ Concern	Risk Characterization		
		Probability (Likelihood of Going Wrong)		
		of contamination	of consumer exposure	of secondary spread among humans
Post Harvest ***Transportation, Warehousing and Distribution*** 50-pound crates of rutabagas are loaded onto trucks and transported to warehouses for distribution to retail stores.	**Physical** Concern that extraneous physical materials such as metal, wood, rocks, glass, plastic, etc., may contaminate the rutabaga. Physical hazards in food are known to cause injury (47, 48, and 49). See Appendix C for a list of physical material hazards and potential injury.	Nglg No issues have been identified. Rutabaga is not likely to incorporate extraneous material into its structure. The probability of any physical extraneous material entering the rutabaga is negligible.	Nglg If contamination occurs, the probability of consumer exposure is negligible. Rutabaga is generally washed and peeled prior to consumption, which should remove extraneous material on or near the surface.	Nglg Physical hazards are not conducive to secondary spread among humans.

Risk Characterization			**Risk Summary**		**Recommendations for Action**
Impact (Consequences of Going Wrong)			**Uncertainty of Data**	**Summary of Risk and Uncertainty**	
on human health	economic	environment			
Nglg If contamination occurs, the impact is variable, depending on the physical hazard and individual.	Nglg If contamination occurs and is traceable to a specific company or industry, the economic impact would be quite low.	Nglg The impact of physical hazards in any food crop on the environment is considered negligible.	Low No previous issues have been identified with rutabagas. Experience and knowledge of rutabaga production provide reasonable certainty of the assessment.	**Nglg** Although the impact is variable and specific data are not known, due to the negligible probabilities of contamination and exposure, it is reasonably certain that the overall risk at pre-production is negligible.	**To reduce risk:** Keep vehicles clean and free of debris. Keep distribution and warehouse facility clean and free of debris.

Activity	Hazard/ Concern	Risk Characterization		
		Probability (Likelihood of Going Wrong)		
		of contamination	of consumer exposure	of secondary spread among humans
Post Harvest ***Wholesale and Retail*** This activity includes storage, handling and display of rutabagas at retail.	**Biological** Concern that pathogens from the environment could contaminate the rutabaga. Worker and customer hygiene. Improper refrigeration on display counter promoting growth of pathogens. Rodent activity in the store. Pathogens contaminating rutabaga from dirty floors.	Nglg-Low At this stage, consumer contact with the rutabagas can contaminate them. There is also a possibility for cross-contamination between contaminated and uncontaminated rutabagas within the displays at retail.	Low If contamination occurs at this stage, the short interval between contamination and consumption increases the likelihood of exposure. Rutabagas are normally peeled prior to consumption, which reduces the probability of exposure.	Low Some foodborne pathogens are easily transmitted directly from person-to-person, or by the fecal to oral route. If infection occurs, secondary spread among humans can occur. While primary spread may be broadly distributed, secondary spread is expected to be mainly local.

Risk Characterization			Risk Summary		Recommendations for Action
Impact (Consequences of Going Wrong)			Uncertainty of Data	Summary of Risk and Uncertainty	
on human health	economic	environment			
Low-High If infection occurs, the impact is variable, depending on the pathogen and individual. The young, elderly, and immune-compromised are at greater risk (40). Symptoms are variable, from mild diarrhea and upset stomach, to extreme cases where death may occur (15, and 78).	Low-Med Direct healthcare costs vary with pathogen virulence, individual vulnerability and size of outbreak. If an outbreak is traceable to a specific company or industry, the indirect economic impact could be high (68).	Nglg Although no specific studies are known, the presence of biological hazards in food crops is considered to have negligible impact on the environment.	Low-Med No previous biological hazards attributed to rutabaga during this stage have been identified. Experience, knowledge of plant growth and the industry, and lack of traceable cases provide reasonable certainty of the assessment.	**Nglg** The probabilities of contamination and exposure are very low. The impact of contamination is mainly low. While there is some uncertainty, the overall risk is expected to be quite low.	**To reduce risk:** Keep display area properly cooled and clean at all times. Monitor and maintain rodent bait stations regularly. Have proper toilet and washing facilities available for workers and customers. Maintain proper temperature on display counters to prevent growth of pathogens. Sanitize produce counter on a regular basis. Keep floors clean.

Activity	Hazard/ Concern	Risk Characterization		
		Probability (Likelihood of Going Wrong)		
		of contamination	of consumer exposure	of secondary spread among humans
Post Harvest ***Wholesale and Retail*** This activity includes storage, handling and display of rutabagas at retail.	**Chemical** Contamination from floor cleaners, disinfectants, or sanitizers. While the level of chemicals in food is quite low, it has been suggested that foods are sources of exposure to chemicals (35, and 36).	Nglg Chemicals are not intentionally applied to rutabagas during this stage. Unintentionally applied chemicals may cause contamination but the likelihood of this occurring is extremely low. The probability of chemical contamination of the rutabaga at this stage is considered to be negligible.	Nglg-Low If contamination occurs, the probability of consumer exposure to chemicals is very low, as most chemicals will be found on the outer surfaces of rutabagas. These surfaces can be washed and/or removed prior to consumption.	Nglg Chemicals are not conducive to secondary spread among humans.

Risk Characterization			Risk Summary		Recommendations for Action
Impact (Consequences of Going Wrong)			**Uncertainty of Data**	**Summary of Risk and Uncertainty**	
on human health	economic	environment			
Nglg-Med While the impact of chemicals on human health is quite low, toxic chemicals can cause numerous health effects in humans including cancer (35, 40, 39, 41, and 42). Non-toxic chemicals have minimal acute effects on human health, although long-term effects are unknown (36).	Low Direct healthcare costs vary with the scope of contamination. If the contaminant is traceable to a specific company or industry, the indirect economic impact may be significant (43).	Nglg At the levels at which chemicals are found in food, the impact of contaminated food on the environment would be negligible.	Low No previous issues have been identified at this stage of production. The lack of traceable cases provides some certainty of the assessment.	**Nglg** Data for specific long-term effects are limited. Overall risk of illness from registered pesticides is negligible to low, due to the negligible probability of contamination and human exposure.	**To reduce risk:** Ensure that any cleaning, sanitizing, and disinfectant compounds are used in accordance with package directions and kept away from the rutabaga.

Activity	Hazard/ Concern	Risk Characterization		
		Probability (Likelihood of Going Wrong)		
		of contamination	of consumer exposure	of secondary spread among humans
Post Harvest ***Wholesale and Retail*** This activity includes storage, handling and display of rutabagas at retail.	**Physical** Concern that extraneous physical materials such as metal, wood, rocks, glass, plastic, etc., may contaminate the rutabaga. Physical hazards in food are known to cause injury (47, 48, and 49). See Appendix C for a list of physical material hazards.	Nglg No issues have been identified. Rutabaga is not likely to incorporate extraneous material into its structure. The probability of any physical extraneous material entering the rutabaga is negligible.	Nglg If contamination occurs, the probability of consumer exposure is negligible. Rutabaga is generally washed and peeled prior to consumption, which should remove extraneous material on or near the surface.	Nglg Physical hazards are not conducive to secondary spread among humans.

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Nglg If contamination occurs, the impact is variable, depending on the physical hazard and individual.	Nglg If contamination occurs and is traceable to a specific company or industry, the economic impact would be quite low.	Nglg The impact of physical hazards in any food crop on the environment is considered negligible.	Low No previous issues have been identified with rutabagas. Experience and knowledge of rutabaga production provide reasonable certainty of the assessment.	**Nglg** Although the impact is variable and specific data are not known, due to the negligible probabilities of contamination and exposure, it is reasonably certain that the overall risk at pre-production is negligible.	**To reduce risk:** Keep the display area and produce counter clean and free of debris. Shield overhead lighting to prevent breakage.