

PERSONAL VIEW

Diabetes on the Navajo nation: what role can gardening and agriculture extension play to reduce it?

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ABSTRACT

Diabetes has emerged as a serious health problem in the Navajo nation, the largest Indigenous tribe in the US. Persons with diabetes are at greater risk for developing other diseases such as cardiovascular disease. Navajos with diabetes almost certainly face a diminished quality of life if their diabetes is not managed properly. Aside from genetics, the incidence of diabetes is highly correlated with income, poor diet, and limited physical exercise. A review of the literature also implicates dietary shifts initiated by historical events and contemporary trends. Numerous studies have shown that moderate consumption of fruits and vegetables, combined with exercise, reduces the risk of or delays the onset of many diseases including diabetes. As part of a larger holistic approach, home and community garden projects have successfully addressed nutrition and food security issues on a grassroots scale. The Navajos have a tradition of farming and therefore expanding Navajo diabetes interventions to include the promotion of community and home gardens provides multiple opportunities. The benefits of these actions include: (i) a variety of nutritious food grown locally; (ii) physical activity attained through the act of daily gardening tasks; (iii) positive income garnered in terms of savings in food otherwise purchased at stores and excess produce canned, or if desired, sold at a farmer's market or trading post; and (iv) positive mental outlook through a combined sense of accomplishment at harvest time, bonding with the earth, and spiritual growth. The objectives of this article were to review the development of diabetes on the Navajo nation through historical and contemporary literature, to provide insight into the role of diet and exercise in the progression of the disease, and to offer cases and



suggestions in the role that home and community gardening can play in diabetes reduction. A concluding discussion proposes a multidisciplinary approach to tackling diabetes on the Navajo nation involving public health officials, nutritionists, and horticultural extension agents that could also be applied internationally in similar multicultural, semi-arid climates.

Key words: diabetes, diet, fruit and vegetable, gardening, Indigenous health, Native American health, Navajo, nutrition, semi-arid agriculture.

Introduction

Diabetes and the Navajo

The Navajo nation, with over 250 000 members¹, is the largest federally recognized tribe within the USA, encompassing nearly 70 000 km² within parts of three states: Arizona, New Mexico, and Utah (Fig 1). The reservation is larger than 10 of 50 of the United States¹. Most of the Navajo nation is extremely remote and rural, and many Navajo live in isolated family clusters. The region is semi-arid although there are significant rangelands, forests and irrigated farmlands. The median age of inhabitants is 22.5 years².

Type-2 (non-insulin dependent) diabetes and the associated cardiovascular disease (CVD) risk are on the increase in the USA. Indigenous American people, including the Navajo, have been particularly hard hit by this trend. In an 8 year period alone, from 1990-1997 the prevalence of diabetes rose 29%³. Diabetes is not in the Navajo tradition. Called 'the sugar illness', the historical progression of diabetes is correlated with colonization by westward expansion of the USA in the 1800's, and often poor federal policy toward Indigenous people that resulted. Gradual shifts away from traditional diets, active lifestyles including hunting, farming, and herding, and adoption of a more Anglo-American diet began to occur⁴. Past federal nutrition guidelines advocating meaty, cheesy foods, criticized for not taking into account traditional diets, exacerbated the dietary transitions of the Navajo^{4,5}. Further, the contemporary rise in consumption of nutrient poor, sugary, processed, and 'fast foods' of

convenience (foods often containing large amounts of trans- and saturated fats), in combination with low intakes of fruits/vegetables and sedentary lifestyles have produced disastrous health consequences^{4,6-10}. For example, the number of reported cases of type-2 diabetes in the Navajo increased from one person out of 6000 in 1937 to 21-23% of the population aged 20 years and older in 1997, or more than 4 times the rate found in the general US population^{11,12}. More than 40% of Navajo adults over 45 years are diabetic, yet one-third of this group is unaware of their diabetic condition¹³. Navajo with diabetes are 2.8 times more likely to be overweight, 2 times more likely to be sedentary and are more likely to suffer premature death related to CVD than their non diabetic counterparts^{6,11,14-17}. A huge concern among this group is the number of children, adolescents, and young adults (<15-24 years) who are receiving diagnoses of diabetes. The prevalence of diabetes in this population increased by 46%, from 6.4 per 1000 to 9.3 per 1000 between 1990 and 1998¹⁸ - more specifically, adolescents aged 15-19 years saw an increase in diabetes rates of 106% between 1990 and 2001²⁰.

The importance of physical activity and healthful eating habits need to be encouraged by families and communities when children are young, allowing them to carry positive health behaviors into their adult lives¹³. Poor dietary habits developed in childhood including unfamiliarity with fruit and vegetables in the diet increase the risk of diabetes in adulthood^{15,20}. This was reinforced in the most comprehensive survey of Navajo health and nutrition where fruit and vegetable consumption were noted as low: consumed less than once, per person, per day⁷.



Figure 1: Map of the Navajo nation (not to scale).



The rise in diabetes among the Navajo is also correlated with socio-economic status and the lack of services in remote areas of the reservation. Major limitations affecting dietary choices have been cited as: cost, availability, shelf life, and remoteness^{6,7}. Lack of purchasing power is associated with the fact that over half of the Navajos live on a yearly per capita income of \$6217²¹ compared to the US per capita income greater than \$30 000²².

A reality on the reservation is that access to quality foods, to include fresh fruits and vegetables, is often limited by the extreme remoteness of areas where Navajos reside¹⁹. Availability of fruits and vegetables on the reservation decreases with distance away from fringe cities such as Farmington and Gallup, NM. Unimproved roads predominate and large distances between communities on Navajo land mean long drives for food shopping. Isolated trading posts bridge the gap between modern grocery stores but often stock limited selections of produce provide minimal nutrition. Many Navajo homes are still without electricity. In 2000 the Energy Information Administration estimated that 36.8% of the 29 375 occupied housing units on the Navajo nation lacked electricity²³. Due to this lack of electricity, home refrigeration is scarce, as are purchases of perishable foods that include some fruits and vegetables.

Why gardening in a diabetes prevention and care program?

It makes perfect sense to promote a return to gardening as a tradition among the Navajo to alleviate diabetes. The Navajo have a longstanding heritage of farming dating back to contact with Pueblo Indian communities and later the Spanish⁴. Consuming fruits and vegetables, exercise, and weight loss are all prescribed for diabetes management^{11,16,24-26}. Gardening, whether in a community or home environment, is gaining popularity for inclusion in diabetes management (and prevention) for a number of reasons²⁷⁻²⁹.

First, gardeners are more likely to adopt healthier dietary habits by consuming what they produce. Indeed, a review of the scientific literature shows that consuming fruits and vegetables in modest portions provides protection against a number of diseases including diabetes³⁰⁻³². The US National Cancer Institute recommends 5-9 servings of fruits and vegetables per day in their 'Eat 5 to 9 a Day for Better Health' campaign^{33,34} and the Native American Food Pyramid advocates 3-5 servings of vegetables and 2-4 servings of fruits per person per day³⁵ (Appendix 1). Parents who garden are more likely to pass this knowledge onto their children³⁶ and thus can begin to break cycles of diabetes.

Second, following the above consumption guidelines, a garden can locally produce a wider variety of nutritious food than what may be purchased at trading posts and smaller grocery stores. Traditional cultivation of several types of corn, beans, squash, watermelons, vegetables such as wild spinach or beeweed (*Cleome serrulata*), chili, berries from wild sumac (*Rhus* sp.), yucca 'bananas' (from *Yucca baccata*) and prickly pear cactus fruit (*Opuntia* sp.) among many others have been described in historical manuscripts and by tribal elders^{4,37}. Cultivating leafy greens (such as leaf lettuce and Swiss chard), orange colored sweet potatoes, melons, and butternut squash all provide a mixture of nutritious produce. Many, if not all of these could be introduced, or reintroduced, to Navajos for incorporation into home or community garden. Although electricity is lacking in some parts of the reservation, many vegetables could be properly stored without refrigeration or canned for future consumption.

Third, gardening does not immediately come to mind as a form of physical activity. The mere mention of the word 'exercise' may elicit negative connotations that gardening does not invoke. Gardening ranked highest in exercise preference among diabetic adults and individuals who engaged in more than one physical leisure activity (including gardening) for 30 min per day, 5 days a week, improved insulin sensitivity and glycemic control and decreased the



need for oral medications or insulin^{11,24,38}. Daily activities of gardening include weeding, cultivating, irrigating, pruning, staking – activities that, for the most part, provide ‘exercise’. Anywhere from 100-120 calories can be burned off in 30 min of light gardening activities, such as hand weeding; more calories burned in digging and raking³⁹. In terms of cardiovascular health, Native Americans who engaged in gardening, among other physical activities, had increased levels of high density lipids (‘good’ cholesterol) over their sedentary counterparts⁴⁰.

Lastly, growing food locally at home or with a group offers the potential to raise rural household income through savings on grocery requirements. Dollars are kept with the Navajo rather than leaked out through off-reservation purchases. Participants of rural home garden projects in South and East Africa acknowledged positive economic savings in not having to purchase vegetables and some actually became interested in selling produce^{41,42}. Small gardens contribute to positive income with every \$1 invested in a garden plot yielding \$6 worth of vegetables (L Sime, pers. comm. 2003). Another example is a one-third hectare 0.3 ha (0.67 acre) community supported agriculture project which produced 9350 kg of vegetables and herbs at an estimated value of over US \$ 20 000 in one growing season (P Pao, pers. comm. 2006). Selling excess produce to farmers markets or even to trading posts could supplement income for progressive individuals or groups.

Gardening programs: cases and components of a diabetes prevention program

A few garden/diabetes programs have been described targeting Native Americans. A 0.4 ha (1 acre) community garden addressing diabetes care in a Northwest tribe was established near the Indian Health Service (IHS) clinic, tribal government offices, and a housing complex serving tribal elders⁴³. Forty home gardens were also established with technical assistance provided by the program. Workshops gave advice on diet, nutrition, and health care and vans transporting the elderly detoured to the garden to allow persons to pick vegetables.

Another project started on the Standing Rock Sioux Nation in North Dakota utilized elementary students to raise vegetable transplants for dozens of gardens located around the reservation⁴⁴. The project first started with a demonstration plot near a high school to catch the attention of students and emphasizes the use of heirloom and native herbs and vegetables. Some of the seed was donated as part of the Native Seeds/SEARCH program⁴⁵.

Miller¹² describes a Navajo diabetes care program, administered by Sage Memorial Hospital in Arizona, taking a similar holistic approach: utilizing a model garden, dietician on staff, and providing information on diabetes care. The garden, which was begun in 2004, is now in its second year with expansions to the town of Burnside, Arizona (Navajo Housing Authority site and Ganado High School) (D Preckshot, pers. comm, 2006). Cooking classes are held twice per month at the hospital to give lessons on diabetes-friendly diets.

A multidisciplinary approach

A Gardens for Health project among the Navajo fosters a culturally sensitive approach in a unique semi-arid growing climate which should promote multi-disciplinary cooperation between health care givers, nutritionists, and horticultural research and extension agents working in tandem with the community, government and individuals. Healthcare workers in the region have focused on: (1) testing for diabetes; (2) treatment in the form of insulin or oral medication; (3) counseling and education on lifestyle changes; (4) promotion of exercise; (5) promotion of diabetes friendly diets; and (6) promotion of healthy food production in the form of small-scale gardens. Agricultural workers in the region have knowledge about: (1) producing crops in a difficult growing environment of low annual rainfall; and (2) crops that garner the greatest return on investment. Traditionally, these parties may not have considered cooperation, each bound to issues relevant to individual disciplines, but by working together many similarities are exposed and faster progression against diabetes can be achieved. Utilizing elements of successful cases discussed



above, a Garden for Health project could be devised from specific components.

Public Health

A Gardening for Health Project presented here is based on the Health Belief Model^{46,47}. The six constructs of the Health Belief Model, as they relate to designing a diabetes prevention and care project are identified in Table 1. Even brief individual counseling sessions of 15 min on the health benefits of fruits and vegetables can induce increased sustained consumption⁴⁸. The same approach of advice given to participants by garden staff on topics such as crop selection, horticultural techniques, harvest information and explained in lay terms can sustain the garden.

Agronomic considerations

The principle agro-climatic barrier to growing fruits and vegetables on the Navajo nation is limited water resources. For example, mean annual rain fall in the northeastern portion of the reservation is low (208 mm)⁴⁹. Crop irrigation is almost exclusively achieved using river, reservoir, or ground water and, in some cases, must be trucked in containers to homesteads⁵⁰. Drip irrigation systems utilize water efficiently by precision placement of water near the plant. As such, less water is wasted, increased land area can be irrigated, and there is less weed pressure because only the crop is receiving water⁵⁰.

The major limitations to adoption of drip irrigation are cost and technological inappropriateness. Home-owner drip systems are widely available at 'do-it-yourself' and hardware stores but are often cost prohibitive to lower income families while commercial systems utilize specialized equipment that may require higher water pressures than those available to typical resource-poor Navajo farmers.

Successful deployment of low cost, simple drip technology has been demonstrated in developing countries with similar agronomic and socio-economic climates found in the Navajo nation⁵¹. Manufactured in India, the KB-Drip system (for

Krishak Bandhu - Bengali for 'farmer's friend') is globally advocated by International Development Enterprises⁵² but has had limited exposure in the USA. The principle operation of these systems is simple: an elevated water holding tank provides enough gravity pressure to drive the system. Fifty-five gallon (208 L) drums are used to store water (Fig 2) and laterals (lines of tubing that deliver water down individual crop rows) are constructed from plastic tubing (Fig 3). Punctures are made into the tubing into which microtubes are inserted to direct irrigation to individual plants (Figs 3,4). The main advantages of this system are cost, simplicity, and weed control. The cost of the system components, excluding tank, are less than US\$50. However, shipping costs from India may double this cost when imported in small quantities. Bulk imports would lower total costs.

Another agronomic barrier on the Navajo nation is frost protection during winter months which prevents year-round production of vegetable crops. Fruit trees adapted to the area are dormant during this period and out of production until spring; however, cold weather limitations for vegetable crops may be partly overcome by selecting cool-season crops tolerant of light freezes such as lettuce and members of the *Brassicaceae* family including broccoli, kale, and cauliflower (Appendix II,III). Other adaptations to extend the growing season of the garden into the cold season are passively heated, low-technology greenhouses or row covers that permit cultivation of a wider variety of crops out of season (Figs 5-7). Low technology greenhouses have been described for both commercial and home applications⁵³ and designs vary as does expense⁵⁴⁻⁵⁶. Most designs utilize the basic 'hoop construction' over which UV resistant plastic is laid and secured. Unlike traditional hobby or commercial greenhouses that use natural gas, coal or electricity to provide supplemental heat during cold periods (which is cost prohibitive), heat is captured in thermal mass within the greenhouse (using black plastic mulching, water bottles painted black, or brick masonry walls among others) and released slowly at night. When outside temperatures are slightly below freezing (32°F or 0°C) inside temperatures remain slightly above freezing depending on the amount of



thermal mass present within the greenhouse. Other modifications include a second layer of plastic or spun-fiber row covering placed over crops within the greenhouse to boost insulation in below freezing weather⁵⁷. The ‘doors’ are rolled up during the day when outside temperatures are

above 60°F (15°C) to vent excessive heat and closed in the late afternoon to preserve heat. The total cost for a 4 x 9 m structure was less than US\$200, which is affordable in the scheme of greenhouses but may be more suitable for community gardens with pooled monetary resources.

Table 1: Health Belief Model Constructs as they could be used in a diabetes prevention and care program

Construct	Action as related to this project
Perceived susceptibility	People will take preventive actions against some conditions linked with potential ill health, if they feel they might be susceptible, such as developing diabetes.
Perceived severity	Based on the potential harm or health condition (diabetes) which could negatively impact the person or their family members, due to inadequate consumption of healthful, fresh foods.
Perceived benefits	The person has the ability through gardening to create a healthy, low-cost, and traditionally appropriate way to enhance their diet and obtain some exercise.
Perceived barriers	May include the potential challenges of learning or adapting gardening techniques to their area of the reservation.
Cues to action	The healthcare personnel at the hospital or clinic can work with the gardening personnel and reinforce the health, nutrition and physical activity message.
Self-efficacy	People are educated about their ability to take control over their diet and their diabetes, grow their own food, and obtain some exercise, in the name of diabetes prevention or intervention.

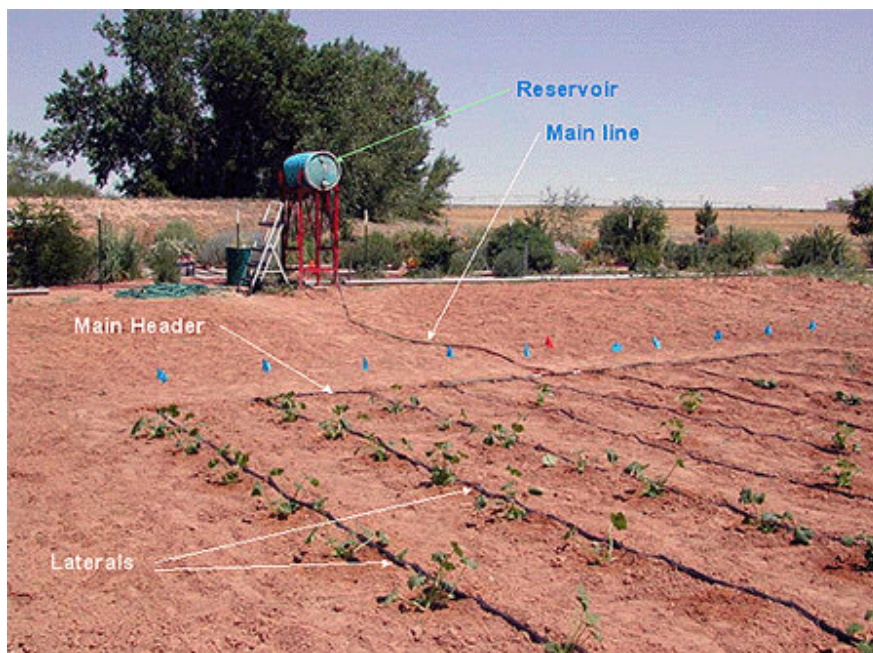


Figure 2: Typical layout of the low cost, low-tech drip system.

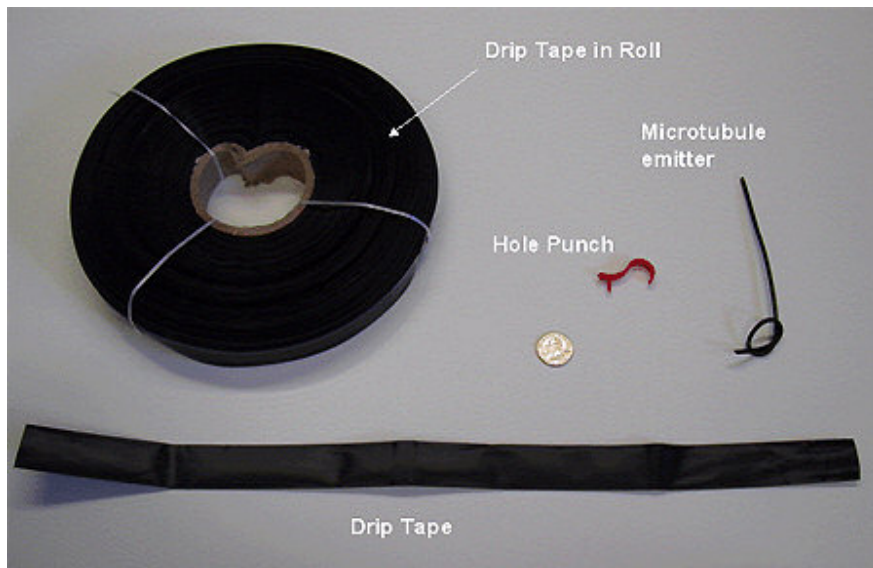


Figure 3: Plastic tubing used for laterals. The tubing is punctured with the hole punch. The microtube emitter is inserted into the hole.

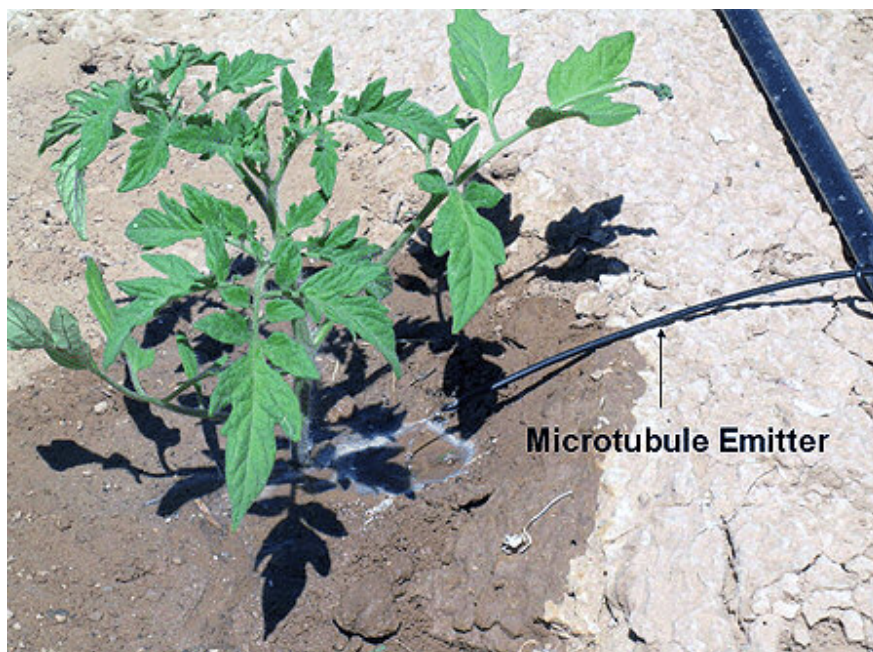


Figure 4: Microtube emitter supplying irrigation directly to the plant.



Figure 5: Exterior of the low-tech, low-cost plastic tunnel for growing vegetables year round.



Figure 6: Interior of low-tech greenhouse; lettuce and broccoli crop pictured. The total cost for this system is less than US\$200 to cover an area 4.3 x 9 m.



Figure 7: Tomato production out of season under plastic.

Demonstration

Above all, the main emphasis on any Gardens for Health diabetes program among the Navajo should be community based in order to build grass roots momentum and sustained behavior change. The success of a Garden for Health project depends first on high visibility demonstration plots near IHS clinics, tribal government offices, chapter houses, schools, churches, trading posts, spiritual gathering places, and progressive family clusters. Without the relevant parties participating, this will not become reality. To demonstrate low cost, low tech drip irrigation systems in the Navajo nation, the University of Arizona and New Mexico State University are collaborating with gardening projects at the Hubble Trading Post in Ganado, AZ and in various chapters in northwest New Mexico.

Summary

Diabetes is a serious health problem in the Navajo nation. The scientific evidence is clear: that diabetes in the Navajo Nation is largely a result of an introduced diet and shifting lifestyle. Poverty and remoteness of communities on the

reservation contribute to the problem. Gardening can help. Nutritious fruits and vegetables are produced closer to home in an individual or community setting. This would increase consumption, enable physical activity in daily gardening practices, and raise rural household income by eliminating some grocery purchases while providing the potential to sell excess produce in a market garden approach. The promotion of simple low-cost drip irrigation and frost protection for year-round vegetable production should be encouraged in the semi-arid Southwestern USA as they would be important components of a comprehensive diabetes prevention and care program. Gardening is a component of diabetes care but a multi-sectored approach involving agriculture, nutrition, health, policy-makers, community leaders, schools, and individuals is required to make faster progress on curbing diabetes in the Navajo nation.

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Appendix I

The Native American food pyramid



Note 3-5 servings of vegetables and 2-4 servings of fruit are recommended per day. Native American food pyramid³⁵, reproduced with permission of the California Adolescent Nutrition and Fitness Program.

For more information on the California Adolescent Nutrition and Fitness Program, please contact:

CANFit
2140 Shattuck Ave
Suite 610
Berkeley, CA 94704
Phone: (510) 644-1533
Email: info@canfit.org



Appendix II

Some vegetable crops and their contribution to the diet, categorized according to season appropriate for a Navajo Gardens for Health^{45,58,59}

Crop	Notes	Crop	Notes
Asparagus	Vitamin K, C, and A. Folate, cardiovascular health benefits	Kohlrabi	Related to cabbage. Vitamin C, potassium
Broad (Fava) beans	Protein, folate, thiamine	Leek	Related to onion. Stabilize blood sugar. Anticancer and CVD benefits.
Broccoli	Protein, Thiamine (Vit. B ₁), Vit. A, Riboflavin (B ₂), Vit. C, P, K, Ca, Glucosinilates (anti-cancer benefits)	Mustard	Related to broccoli, cabbage. Multiple vitamins, anti-cancer benefits. Seed and leafy greens consumed.
Brussels sprouts	Ca, Riboflavin (B ₂), Vit. C	Onion	Anti-cancer/antioxidants. Cardiovascular health benefits
Cabbage	Vitamins K and C. Fiber, minerals, anti-cancer properties	Parsley	Vitamin K, C, and A. Antioxidants benefits
Chive	Related to onion	Pea	Multiple vitamins, minerals, protein, antioxidant benefits
Collards	Leafy green. Multiple vitamins. Anti-cancer, antioxidant benefits	Radish	Potassium, vitamin C, folate
Garlic	Related to onion. Anti-oxidant, cardiovascular health benefits	Rhubarb	Red stalks are consumed. Vitamin A and C.
Horseradish	Herb	Spinach	Multiple vitamins and minerals. Antioxidant/anticancer benefits
Kale	Leafy green. Multiple vitamins, anti-cancer benefits	Turnip	Leaves consumed have multiple vitamins and minerals anti cancer and CVD benefits. Roots high in vit. C, fiber
Beet	Folate, antioxidant benefits	Globe artichoke	
Carrot	Beta-carotene/antioxidant benefits	Endive	Similar to chicory
Cauliflower	Vitamin C, anti-cancer glucosinilates	Lettuce	Leaf lettuce source of fiber and
Celery	Source of fiber	Parsnip	Similar to carrots. Folate and vitamin C
Chard	Vitamin A	Potato	Native to the Americas
Chicory	Leafy green vegetable	Salsify	Grown for edible root
Chinese cabbage	Similar to cabbage		
Cowpea/Blackeye Pea	Calcium, folate, vitamin A, protein	Soybean	Protein. Anti-cancer benefits
New Zealand spinach	Not related to spinach but consumed as a leafy green	Corn	Native to the Americas. Thiamin, fiber
Snap bean	Multiple vitamins and minerals. Protein. Anti inflammatory and CVD benefits	Tomato	Lycopenes/antioxidant benefits
Sorghum	Drought resistant. Iron, potassium and calcium	Tomatillo	Related to tomato
Sunflower	Native to the Americas. Seed crop. Antioxidant benefits		
Amaranth	Native a small grain cultivated in Mexico and Southwestern Indians and eaten for grain and leaves. Spring/summer	Okra	Africa. Vitamin C
Common beans (Pinto)	Native to the Americas. Fiber, folate, minerals and vitamins protein	Chili pepper	Native to the Americas. Vitamin A, anti-CVD benefits
Cucumber	Fiber, vitamin C	Sweet pepper	Similar to chili pepper. Vitamin C and A, anti-CVD benefits
Eggplant	Related to tomato. Fiber, antioxidant benefits	Pumpkin	Beta-carotene, fiber, vitamin C. Roasted seed have multiple health benefits



Appendix II continued

Crop	Notes	Crop	Notes
Lima bean	Native to the Americas. Fiber, minerals, vitamins, protein	Squash	Related to pumpkin with similar benefits. Many kinds of squash exist
Tepary beans	Native to the Americas. Fiber, minerals, vitamins, protein	Sweet potato	Vitamin A. "anti-diabetic" food good for blood sugar control
Muskmelon/cantalope	Vitamin C, vitamin A, antioxidant benefits	Watermelon	

List is not all inclusive for vegetables that can be grown or for health benefits.

Appendix III

Sources of seed or garden program information

Native Americans are entitled to free membership in Native Seeds/SEARCH and may receive free seed to start their gardens⁴⁵. Other sources of heirloom varieties include Seeds of Change.

Native Seeds/SEARCH

Website: http://www.nativeseeds.org/v2/native_benefits.php

Phone: Toll-free (866) 622-5561

Fax: (520) 622-5591

info@nativeseeds.org

Mailing Address

Native Seeds/SEARCH

526 N. 4th Ave.

Tucson, AZ 85705-8450