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Reestablishing the Juneberry on the Fort Berthold Indian Reservation:
Cultural, Horticultural, and Educational Connections

BY

Kerry E. Hartman

A dissertation submitted in partial fulfillment of the requirements for the

Doctor of Philosophy

Major in Biological Sciences

South Dakota State University

2008

Reestablishing the Juneberry on the Fort Berthold Indian Reservation: Cultural,
Horticultural, and Educational Connections

This dissertation is approved as a creditable and independent investigation by a candidate for the Doctor of Philosophy degree and is acceptable for meeting the dissertation requirements for this degree. Acceptance of this dissertation does not imply that the conclusions reached by the candidate are necessarily the conclusions of the major department.

Dr. Neil Reese
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Date

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Date

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Dedication

I wish to dedicate my dissertation to the Tribal Elders living and journeyed on of the Mandan, Hidatsa, and Arikara Nation. My efforts would not have been possible without their assistance. More importantly I need to thank them for the guidance and feelings they shared with me on this project and many others. Their wisdom and strength have carried them through incredibly difficult journeys. My sincerest hope would be that my efforts may result in some small way to achieve their wishes for the Juneberry to be once again available for their children and grandchildren to enjoy. I also wish to dedicate this dissertation to my children Krystal, Jaime, and Lukas and my grandson, Jordan. We will now have more time to fish, garden, and play. I know that you will all strive to achieve your highest capabilities-whatever they may be.

ABSTRACT

Reestablishing the Juneberry on the Fort Berthold Indian Reservation: Cultural,
Horticultural, and Educational Connections

Kerry E. Hartman

2008

Tribal people of the Northern Great Plains have utilized plants for centuries. *Amelanchier anifolia* (Juneberries/Serviceberries) historically played an important part in the diet and culture of the Mandan, Hidatsa, and Arikara (MHA) Tribal Nations. Research conducted as part of this study into historical and contemporary uses of the Juneberry by MHA Tribal Members indicated extensive historical use and a high interest in Juneberry reestablishment for cultural, nutritional, and economic reasons. Previous research on Juneberries has investigated factors including state of dormancy, propagation method, transplant type, and mulch type. Another purpose of this study was to elucidate the impact of presence of water, cultivar type, soil type and site on the transplant success rate of Juneberries on the arid Northern Great Plains. Alternating experimental units of *Amelanchier anifolia* cultivars (Honeywood, Smokey, and Martin) were planted with and without presence of water on three selected sites within the Fort Berthold Reservation. Precipitation levels and plant vigor were monitored. Soil type, and cultivar differences were insignificant, however, presence of water results indicate its necessity. A plant-based curriculum framework was presented to improve cultural relevancy for students at Tribal Colleges.

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CHAPTER 1. INTRODUCTION

Introduction

Amelanchier contains over twenty-five species that are indigenous to the North American continent (North Dakota State Extension Service. 1996). The Juneberry as it is called by the Plains Indians belongs to the genus *Amelanchier*, sub family Maloideae, family Rosaceae, which also includes *Amelanchier laevis*, *A. oblongifolia*, *A. aborea* and several other species that produce edible fruit and are commonly called serviceberries, shadbush, Saskatoons, apple serviceberry, and others (Pruski, et. al, 1991). The Juneberry and other members of the subfamily Maloideae produce pome fruits. All species of *Amelanchier* produce delicious, sweet flavored, black berry like pomes in the early summer.

The flavorful and nutritious berries of the various species of the genus *Amelanchier* have been used by Indigenous people of North America for centuries. The members of the Mandan, Hidatsa and Arikara (MHA) Nations utilized the Juneberry in their diet and for other purposes for the centuries that they have lived in the Missouri River bottom lands, from present day Kansas to North Dakota. In 1952 the United States Government Army Corps of Engineers flooded their Fort Berthold Indian Reservation homelands through the construction of the Garrison Dam and its resulting reservoir. All members of the MHA Nation were relocated to the arid plateaus, which remained unflooded. Their dietary customs were drastically altered by this change in their environment including their utilization of wild fruits especially the Juneberry.

Recently, considerable interest has been expressed by MHA tribal members in revitalizing numerous aspects of their traditional cultures. Included in these efforts to preserve language and social customs has been an interest in reestablishing traditional nutritional practices. One historically important dietary practice was the harvesting and consumption of the Juneberry (NRE Talking Circle Transcripts, November 14, 2001).

Due to the flooding of the bottom lands and the relocation to the plateaus of the reservation, the availability of wild Juneberries has become extremely limited. It has become evident to many that the reintegration of Juneberries into the social, educational and nutritional practices of MHA tribal members would require the cultivation of large plots of the shrubs. Unfortunately there was little scientific information available regarding the establishment and care of private or commercial size Juneberry plots on the arid windy plateaus of Fort Berthold Indian Reservation of North Central North Dakota.

One focus of the research was to gather primary data regarding the historical usage of Juneberry by the members of the MHA Nation. While there is considerable secondary and archival data regarding Juneberry use (Gunderson, 2003), there is minimal written historical accounts of Juneberry uses by the MHA Nation. Results of the study provide a comparison of the degree of Juneberry use before the flooding of the river valley and present day usage. This information will provide documentation as to the impact of the flooding upon the MHA tribal members' diets. An additional result of this research will be documentation of the interest in re-establishing Juneberry stands on the Fort Berthold Indian Reservation.

Another purpose of this study was to evaluate the impacts of soil, cultivar, and presence of water upon transplant success of the Juneberry. Numerous replications of combinations of these variables were monitored for two years at three sites located across the Fort Berthold Indian Reservation. Transplant success rates and growth indices were used to determine optimal transplant procedures for Juneberry on the plateaus of Fort Berthold Indian Reservation.

The results of the Juneberry research and the insights provided by the elders were also used to develop a curriculum for reintegrating native plant information into a Tribal educational system. In recent decades there has been a focus on Native efforts to improve the quality of education being delivered to their young tribal members primarily by reinforcing traditional knowledge including language and culture to promote academic performance. A methodology has been developed and described as an offshoot of this research for building botanical, historical, nutritional, mathematical, and/or language lessons around an indigenous plant that has been traditionally used by any tribal nation for cultural inclusion into their curriculum.

Review of the Literature: Cultural and Historical Uses by Indigenous Cultures

Juneberries have long been a treasured prairie wild fruit. Historically, the hardy native shrub was widely used by many North American Indian Tribes (St-Pierre, 1999). Many tribes held ceremonies and feasts related to Juneberry flowering and harvest. Various ethnographers report that burial of the fruit was a ceremonial thanksgiving. Another example of ceremonial use of the Juneberry included the Blackfeet utilizing Saskatoon blossoms in their tobacco planting ceremony. Some Sun Dances were held when the fruit was ripe. The Klamath believe that the First People were created from Saskatoon bushes (St-Pierre, 1997).

Juneberries plants were used for many applications in addition to their ceremonial uses. The fruits were a common ingredient used in dyeing clothing and accessories such as quill work. The fruit was widely used as a trade item. Uses of the wood included tools, furniture, sports equipment (lacrosse sticks), basket frames, and canoe cross pieces. Juneberry stems were used by many tribes for making arrows, due to their strength and straightness (St-Pierre, 1997).

Medicinal Uses

Largely non-Native ethnographers have reported the following uses. Iroquois women used the fruit to strengthen the body after childbirth. They also drank a root and bark concoction to prevent miscarriage. Additionally, the berries were used to get rid of parasitic intestinal worms (Foster & Duke, 1990). The Thompson Indians drank a warm decoction (decoction-extracting by boiling) and used the same as a wash after childbirth. They also created a decoction for stomach problems. The Southwestern Pomo used a

decoction of the roots to treat too frequent menstruation (Moerman, 1990). The Standing Rock Sioux made a tea of petals, leaves, and small stems and used it on a daily basis (Kraft, 1990). The Mandan, Hidatsa and Arikara tribes utilized the Juneberry in much the same ways as stated above.

Food Uses

The Juneberry (along with the choke cherry, *Prunus virginiana* and bull/buffalo berry, *Shepherdia argentea*) was the mainstay of the fruit component of most Native diets. Due to their importance most of the tribes distinguished between the different types of Juneberries by their various characteristics ranging from ripening time to taste. The Okanogan Indians distinguished eight different types of Juneberries varying in their suitability for eating fresh or drying (St-Pierre, 1999). Fruit were used fresh or steamed in multiple ways ranging from pudding to syrup. They were also mashed and dried to a brick-like consistency for reconstitution at a later time when they were added to numerous recipes from stews to cornballs. Pemmican, a mixture of dried lean meat, melted fat, and Juneberries molded into cakes would keep for months in a cool, dry place and was a winter staple of many Northern Plains tribes.

Historical Uses of Juneberries by the Mandan, Hidatsa and Arikara Nations

Religious Uses

The Mandan, Hidatsa and Arikara people, like many other Indigenous Nations, also used the Juneberry in some of their ceremonial practices. Flowers and fruit were important in native ceremonies and feasts related to Juneberry flowering and harvest, personal communication (D. Wilkinson, May 2004). During the Arikara Bear Society

initiation “a bowl of Juneberries and a dish of cherries were placed near the muzzle of each bear skin” (North Dakota History Journal, 1954). An article describing the Piraskani Ceremony bears a reference to Juneberry wood and berries. The reference states “The pipe-rest is made of Juneberry wood. God gave command to Mother Corn that the wood of this tree should be used for this purpose because it is a tree which bears fruit which is good for human food; it is life-giving” (Gilmore, 1922). Juneberries appear in the stories and traditions of the Arikara. In the story entitled, *The Young Man Pitied by the Spotted Buffaloes*, picking Juneberries in the winter is one of the impossible tasks ordered by the evil father-in-law upon the young suitor of his daughter (Parks, 1996). According to Hidatsa oral historian, Delvin Driver, Juneberries as well as other berries were included in the four foods that were placed in the four holes which held the main posts of the Hidatsa earth lodges. Accompanying prayers were said to bless the grounds upon which the future home would be built (Delvin Driver, personal communication, November 2007).

Food Uses

Juneberries were also included in the diet of the tribal members of the Mandan, Hidatsa and Arikara Nations for centuries. The journals of Lewis and Clark include references to Juneberries being included in Fort Mandan Pemmican, which is based on recipes supplied by the Mandan, Hidatsa, and Arikara Tribal Members (Gunderson, 2003).

In interviews with historian, Gilbert Wilson, Buffalo Bird Woman, Maxidiwiac discussed the White Juneberry, *Matsuataki*. She reported that they were found in small

groups in the Independence area. She further reported that both the wood and the fruits were used in the same way as the regular Juneberry. She also reported that the fruit were of the same sweetness as the regular Juneberry (these fruit were probably what we now call the Paleface cultivar) (Wilson, 1916). Juneberries were an integral component of the healthy diet practiced by the Mandan, Hidatsa, and Arikara people for centuries and until flooding of the fertile bottomlands occurred as a consequence of building the Garrison Dam (Conti, 2006).

The book, *Dams and Other Disasters*, describes the Mandan, Hidatsa and Arikara Nations as living in a valley with fertile land for agriculture and wild fruits. Their way of life was a gardening gathering hunting economy where “Grandmother River” provided the necessities of life (Morgan, 1971). During the May 27, 1946 hearing held in Elbowoods, North Dakota, between Colonel Pick and tribal leaders, tribal elder, Anna Dawson testified against the dam. Included in her testimony against the Garrison Dam, Anna told Colonel Pick her family had canned dozens of quarts of Juneberries that spring; something that they would not be able to do in the future due to the building of dam (Transcript of Meeting at Elbowoods, May 27, 1946; U.S. Senate Committee on Indian Affairs, 1945). Decades after the flood caused by the dam, Tribal Councilwoman, Marie Wells, testified before the Joint Tribal Advisory Committee (JTAC) how she had grown up in the bottom lands near Nishu where and the rest of her family had picked Juneberries. She stated, “They were the ones that fell down first” (Van Develder, 2005).

Even today tribal elders still reminisce about their lifestyle before the dam with frequent references to the harvesting and use of Juneberries. At Fort Berthold Community

College, a Natural Resource Education project, a series of Talking Circles, was conducted to gather input from Tribal Members on future projects FBCC should start. The re-establishment of native plants with special mention of Juneberries was one of the strongest recommendations from the Talking Circle participants (NRE Talking Circle Transcripts, November 14, 2001). At a Juneberry workshop conducted by FBCC at Tribal elder told the fifty interested attendees about her family's picking, eating and storing of Juneberries (Juneberry Workshop Transcript, November 5, 2003). During ceremonies and presentations celebrating the completion of the new Four Bears Bridge located west of New Town, North Dakota, numerous elders' presentations included references to gathering of berries including Juneberries in the bottom lands before the flood (Ogden, October 6, 2005). At a cultural symposium titled, "Echoes from the Bottom Lands", speakers including tribal leaders and others Cultural/Spiritual Panel Members repeatedly mentioned gathering and eating of berries including Juneberries during their panel discussions (personal notes, Kerry Hartman, March 24, 2006).

Present Uses of Juneberries by the Mandan, Hidatsa and Arikara Nations

The Juneberry, although, greatly decreased in availability, is still used extensively by members of the Mandan, Hidatsa, and Arikara Nations. Known plots of wild Juneberries are harvested by hand; berries are eaten primarily fresh, dried, or more commonly frozen. Their uses still include puddings, cornballs, dried patties, and toppings for pastries and ice cream. Re-hydrated and thawed berries are utilized in most of the same ways during the winter months for treats.

The various species of the Juneberry have been an integral part of the ecosystem and Native cultures of North America for centuries. They provided multiple uses for humans, animals, and other organisms within the biomes of this continent. These hardy native shrubs had and still have important roles in nature and the Indigenous cultures of North American. These roles should be studied, respected, strengthened and expanded.

Review of the Literature: Horticultural

The Juneberry belongs to the **Kingdom** Plantae, **Phylum** Tracheophyta, **Class** Magnoliopsida, **Order** Rosales, **Family** Rosaceae, **Sub Family** Maloideae, **Genus** *Amelanchier*, which includes *Amelanchier laevis*, *A. oblongifolia*, *A. aborea* and several others commonly called serviceberries, shadbush, Saskatoons, and apple serviceberry (Pruski, et. al, 1991). Rosaceae includes trees, shrubs, and herbs comprising about one hundred genera and three thousand species with most species having alternate leaves and stipules (*Amelanchier arborea*. Zipcodezoo.com/Plants/A/Amelanchier.aborea.asp). Only the Juneberry and Mayhaw members of the subfamily Pomoideae are native to the United States. There are over twenty-five species of Juneberry found in North America. At least three plant forms are native in North Dakota, but separation is difficult (Laughlin, & Smith, 1988).

The Juneberry produces a pome fruit. The pome is derived from a flower with an inferior compound ovary, which is different from other subfamilies of the Rosaceae family. The edible portion is derived in part from non-ovarian tissue. The Juneberry is a medium sized shrub or sometimes a small tree, which has, simple alternate leaves with

either toothed or smooth margins. Juneberry flowers are produced on racemes, bright white in color, and appear in mid to late May (Pruski, et. al, 1991).

The various cultivars of commercially available Juneberries have their origins in Alberta, Canada where in 1918 Dr. W. D. Albright selected and planted wild bushes to form a hedge alongside his garden. Dr. W. T. Macown then Dominion Horticulturist selected a number of superior bushes from this hedge in 1928 (Pruski, et. al, 1991). These selections were tested for a number of years along with clones from other areas, and in 1952, Selection #9 was released under the name Smoky along with Pembina, which had been collected in Barr Head region of Alberta, Canada by Mr. J. A. Wallace (Pruski, et al, 1991). Numerous cultivars have been named by horticulturalists over the years. These have been mainly chance seedlings that have been selected for superior plant and/or fruit characteristics (Mazza, & Davidson, 1993). Some of the favorite cultivars of Juneberries for growing commercially include Honeywood, Martin, Northline, Pembina, Smoky and Thiessen (Pruski, et al, 1991, p.164-165).

Juneberries grow throughout most of the North American continent. *The A. alnifolia* (Saskatoon and alder-leaved serviceberry) grows from Alaska to southeastern Quebec and northern California, which is USDA Plant Hardiness Zones 4-5. *A. canadensis* (shadblow serviceberry, thicket serviceberry) ranges from the eastern seaboard to central New York, which is USDA Plant Hardiness Zones 3-7. *A. arborea* (Juneberry, shadbush, downy serviceberry, and service tree) grows from eastern Canada to northern Florida, west to Oklahoma, and up to Minnesota, which is USDA Plant Hardiness Zones 4-9 (Ciesinski, 2003). The current status of all species is that their native ranges have been

extremely adversely impacted by modern urban sprawl, agricultural practices including grazing, and loss of habitat. There are no scientific data on historical range densities but expert estimates believe Juneberries have decreased to less than 10% of their historical population (North Dakota State University, 1996).

Characteristics of Various Species

All species of serviceberries prefer moist, well-drained acid soil in either full sun or partial shade. However *A. alnifolia* tolerates alkaline soil well. While all can be pruned to a shrub, *A. alnifolia* commonly grows to 30 feet, *A. arborea* can grow to be 25 feet and *A. canadensis* is the “runt” with normal maximum height of 20 feet. All produce delicious, sweet flavored, black berry like pomes in the early summer. These fruits are the prime focus of the interest in the serviceberries. Cultivars of Juneberry share the basic characteristics with significant differences in fruit size, taste, color, hardiness and quantity of fruit. For example, Pembina produces large full flavored sweet fruit in large clusters, as opposed to the Paleface, which has large white, and mild flavored fruit, which bruise easily and turn brown. The Success cultivar is high yielding, but the fruit ripens slowly, tastes bland, and holds tenaciously to the flower pedicel (North Dakota State Extension Service, 1996).

The members of the MHA Nation used the Juneberry for food, furniture, and weapons for centuries. The availability of wild Juneberries was nearly totally eliminated by the Pick-Sloan Plan of the 1940's and 1950's, which flooded the Missouri River Bottom Lands from Montana through Nebraska with six huge main-stem dams and resultant reservoirs. By no accident these reservoirs primarily inundated Indian

Reservations. This annihilation of native habitats had huge negative impact on the riparian ecosystem and on the Juneberry populations and therefore, their uses on the Northern Plains Reservations. On Fort Berthold Reservation, communities and individuals have begun to reintroduce large plots of Juneberries cultivated to replace the lost wild native stands and rekindle their traditional uses. Plans are also underway to utilize the economic benefits of these Juneberry plots. One reason for this research was to provide scientific data regarding the effects of water, site, and soil type on seedling transplant success rates to help with these ongoing efforts.

Horticultural Development of Juneberries

Research in Canada has demonstrated that many factors including cultivar, state of dormancy, propagation method, transplant type, transplanting date, weeds, wind, water-stress, and mulch type can affect transplant survival (St-Pierre & Tulloch, 2002). Furthermore, late transplanting, forcing early termination of dormancy, and bare-root transplanting all reduced transplant survival. With so many factors negatively impacting plant survival, one would wonder why any Juneberries are planted in Canada (St-Pierre & Tulloch, 2002). Yet, commercial Juneberry production is a thriving industry north of the international border, with fruit being used in numerous baked goods, jams, wines, and ice cream. Canadian production acreage greatly exceeds that of the United States and continues to increase annually, but current production cannot meet the demand by processors (St-Pierre, 1999). There are ongoing research projects in Canada and North Dakota to better understand transplant attrition. Considerable efforts are underway to

determine the impact of fertilization, presence of water, soil type, weed control, and cultivar type upon transplant attrition.

There is still a paucity of data on the effects of these variables on Juneberry production on the uplands and river bluffs in North Dakota. The impact of water, soil type, and cultivar introduction are being studied because the most probable sites for reestablishment of Juneberry stands or orchards are on the relatively high, arid, and rocky soils of Fort Berthold Indian Reservation. In the Agri-Facts newsletter, a publication prepared by the Alberta Agriculture, Food and Rural Development Department, (Hausher, June, 2000) it has been stated that the presence of water is required to establish young Juneberry plants and that supplemental water is necessary in mature plants to maximize Juneberry production. Another study indicated the negative impact of water stress on transplants in dry arid environments (Villagra & Cavagnaro, 2006). However, presence of water is very limited on the Fort Berthold Indian Reservation and research is needed to find the best approach to successful cultivation of Juneberries under these conditions.

Transplant success of various cultivars in Canada examined site selection, and several other variables in a study completed by St. Pierre and Tulloch in 2002. In this study, too little water and no wind protection had a substantial negative impact on successful transplant establishment (St. Pierre & Tulloch, 2002). There were significant differences between the cultivars studied in survival and growth rates although all cultivars were acceptable (St. Pierre & Tulloch). St. Pierre and Tulloch's study investigated only one of the cultivars included in this study. These cultivars (Smokey,

Honeywood, and Martin) were selected due to their commercial availability and their established preferred plant and fruit characteristics (St. Pierre, 2000).

Soil type and presence of water have been addressed extensively in numerous reports. These studies document the impact on soil water retention by several different types of soils while stressing the importance of soil water monitoring for maximum impact of presence of water success (Ley, et al, 1996, Springer, et al, 1999; Noborio, et al, 1996). Key findings include: the importance of the assessment of soil type, water-holding characteristics combined with periodic soil/water monitoring and measurement. Although soil/water monitoring and management plans are important they must include economic and environmental impacts of providing water (Ley, et al, 1996).

While all of these studies provide useful data on their specific topics none of them combined all of the variables that this researcher's study involves. Furthermore the available data is limited as none of this research includes soil and climate conditions present on the Fort Berthold Indian Reservation located in North Central North Dakota.

Review of the Literature: American Indian Education

The subject of quality education has been an area of conflict and concern since the first compacts were formed between the indigenous people of North America and the European settlers. Educational policies and methodologies have been implemented and soon rejected as failures with alarming regularity. The following pages will provide an overview of the evolution of American Indian/Alaska Native education, discussion of its current status, and presentation of a culturally relevant and plant-based curricula framework designed for implementation in any tribal school, college, or university.

Legal obligation for the education of the Indian was first officially granted to the newly formed Bureau of Indian Affairs (BIA) by the Act of March 1, 1873 (Deloria, 1994). Prior to that Congressional action various approaches to peacefully resolving many issues including education had been tried through various Treaties and agreements. These agreements included a wide variety of approaches to settling differences including repeated agreements by French fur traders, which promoted intermarriage with a blend of cultures to the British effort to acculturate the Indians sufficiently for successful exchange of currencies (Cajete, 1994). Official government policies regarding Indian education for later assimilation resulted in an era of Mission Schools in the late 19th century. The Mission School concept later evolved into an era of government boarding schools led and best characterized by the Carlisle, PA boarding school of Colonel Richard Henry Pratt (Reyhner & Eder, 1989). These boarding schools forced mass off-reservation, largely vocational education designed to eliminate native cultures and produce employable American citizens. The concept of boarding schools was largely abandoned due to excessive costs and the largely unsuccessful educational results (Cajete, 1994). The shocking conditions existing in BIA run boarding schools gained national attention through the results of an investigation of Indian affairs ordered by Secretary of the Interior, Hubert Work (Reyhner & Eder, 1989). The report of this investigation, published in 1928 as the *Problem of Indian Administration*, more commonly known as the Merriam Report (1928) eventually led to the demise of the boarding school concept. It also resulted in the eventual actions by President Hoover's appointee, Charles J. Rhoads-Commissioner of Indian Affairs, to remove the uniform

BIA curriculum that only stressed the cultural value of whites (Szasz, 1977). These efforts to improve Indian life and education were strengthened and expanded by Franklin D. Roosevelt's Commissioner of Indian Affairs, John Collier. Collier's appointee to Director of Indian Education, Willard Beatty, started some of the first bilingual and English Second Language programs in the United States (Szasz, 1977). Unfortunately, the United States became preoccupied with World War II during this same time period. Gains in policies and practices of cultural inclusion were lost as victims of the war effort.

Reservation day schools, tribal schools, Bureau of Indian Affairs schools, state funded public schools have all been involved in education of Native American/Alaskan youth since the mid 20th century with various levels of failure marked by high levels of drop-outs, low graduation rates, poor academic performance. Fortunately, in the early 1970's, the rising levels of tribal sovereignty and control revealed the unacceptable status of the education being delivered to Native American/Alaska Native students. The first official document of this era to disclose the state of Indian education was the report "Indian Education a National Tragedy-A National Challenge" (1969). This report, also known as the Kennedy Report, along with vocal and active tribal leaders and members nationwide resulted in the passage of the Indian Education Act of 1972 (Public Law 92-318).

This act was followed by the Indian Self Determination and Educational Assistance Act of 1975. These acts have focused Native efforts to improve the quality of education being delivered to their young tribal members, primarily by reinforcing traditional knowledge including language and culture to promote academic performance.

These efforts were continued and expanded in the 1990's due to the United States Department of Education Report entitled "Indian Nations at Risk: An Educational Strategy for Action" (1991). The movement for Tribal Self-Determination was further supported by Executive Order #13096 signed by President Bill Clinton on August 6, 1998. One result of the Executive Order of 1998 was the document "American Indian and Alaska Native Research Agenda" (2001). This agenda was an outline of how Native people would develop and implement educational systems, which would perpetuate Native culture and language to promote academic success. Unfortunately, these efforts at cultural inclusion and language preservation have been negatively impacted by the "No Child Left Behind Act (NCLB)", which emphasizes and rewards traditional middle class values in education through a rigid standardized curriculum where satisfactory progress is determined by standardized testing (Indian Country Today, 7/25/2007). As recently as 2006, the United States Department of Education advised Indian Education Programs receiving monies from the Title VII-Address the Unique Cultural and Educational Needs of Native Children funds "to shift their focus from the teaching of culture to math and reading" (Gilbert, p.3, 4/28/2007). The immediate future of Native efforts to expand culturally related and Native language based activities into their curricula may hinge on the future of the current administration and "No Child Left Behind". The continuation of NCLB policies will make culturally related and place based curricula difficult to implement due to standardization of curricula.

The plant-based curriculum framework proposed here is an example of one approach at integrating culturally related information and activities to produce a quality

science-based curriculum. The framework outlines activities related to one of the six themes that emerged from a review of research literature entitled “Improving Academic Performance among Native American Students: A Review of the Research Literature (Demmert, 2001). The six themes include early childhood environment and teaching style to parental influences and learner characteristics. The theme of this study that is addressed by the plant-based framework is Native language and cultural programs in schools (Demmert, 2001). As previously stated the inclusion of Native culture and language, being an integral part of the education delivered to Native American/Alaska Native youth, was recommended in the Merriam Report of 1928, the U.S. Senate Report of 1969, Indian Nations at Risk Task Force 1991, and the White House Conference on Indian Education 1992 (Demmert, 2001). A large body of research exists addressing the positive impact upon academic performance of a congruency between the language and culture of the community and the school environment (Bowman, et al, 2001) this congruency between school success and community inclusion has repeatedly been shown to also apply to inclusion of Native American/Alaska Native languages and culture. Including language and culture improves student academic performance; decreases dropout rates, improves attendance, and decreases behavioral problems (Barnhardt, 1999; Alaska Native Knowledge Network, 1998; deMarrais, 1992; Deyhle & Swisher, 1997; Rubie, 1999; Rudin, 1989; Slaughter & Lai, 1994; Smith, et al, 1998; Stiles, 1997; Temp, 1974, Watahomigie & McCarty, 1994; Yagi, 1985). Implementation of the proposed curriculum model utilizing indigenous plants historically known and used by the Nations

of that area would offer the learners the benefits of culturally related activities as well as Native language inclusion.

The proposed plant-based framework also incorporates aspects of other indigenous and environmental science models. Cajete (1994) promotes the approach to education, particularly science education, which utilizes a holistic approach to learning about the natural world by experiencing the interrelated world of all things. A native plants curriculum framework could complement this approach by also involving the weather, soil, water, other plants, insects, birds, etc. Another concept included in the proposed curriculum framework that is integral to Native knowledge systems and cultural identities in general is that of place. Native Americans/Alaska Natives cultures and educational practices have incorporated and utilized a rich sense of place throughout history (Semke, 2005). Native people traditionally perceive themselves as embedded in a web of dynamic mutually respectful relationships among all natural features and phenomena of their homelands (Cajete, 2000). Therefore plant-based curricula models are a natural fit when educating Native American/Alaska Native learners.

The following sections will discuss the botanical variables investigated, the documentation of cultural and historical uses of the Juneberry by members of the Mandan, Hidatsa, and Arikara Nations prior to and following the forced relocation by the floodwaters of the Garrison Dam and introduce a plant-based curriculum framework for use with Tribal Community Colleges and other reservation educational institutions.

CHAPTER 2: IMPACTS OF WATER AND SOIL TYPES ON TRANSPLANT
SUCCESS RATES OF SELECTED CULTIVARS OF JUNE BERRY ON THE FORT
BERTHOLD RESERVATION

Introduction

Juneberries (*Amelanchier spp.*) are indigenous to North America and have been utilized by Tribal Nations of this continent for centuries. The Mandan, Hidatsa and Arikara (MHA) people of the Missouri River Valley heavily utilized the plants (Moerman, 1990). The delicious, nutritious berry-like fruit were consumed in many different forms, the branches were used for arrows and furniture; the leaves and flowers had ceremonial uses. Unfortunately, due to the building of the native habitat of the Juneberry on the reservation was greatly reduced. Before the flooding of the lowlands and moving of the towns and cities to the upland prairies, most of the Tribal communities occupied and utilized a mixture of riparian flood plain, woodland and forest habitats. Additionally, the ravine woodland plant communities, that led up to the mixed grass prairies on the surrounding hills and plateaus, provided a wide range of traditional foods. The ravine woodland was the primary location of the Juneberry. It occurred mainly in seasonally moist draws that were dominated by brushy shrubs and small trees. The most common species included burr oak, buffalo berry, wild plums, hawthorne, American elm and bass wood trees. Historical evidence indicates that Juneberries were not present on the hills where the mixed grass prairie existed (Nature Conservancy, 2008).

In recent decades many Indigenous populations, including the MHA Nations, have acted to reestablish their traditional customs (NRE Talking Circles, 2001). On the Fort Berthold Reservation, one focus of this reawakening of these historical and cultural practices has been the reestablishment of the Juneberry. Due to the flooding of most of the Juneberry habitat, reestablishment of Juneberries requires planting of cultivated plots. Unfortunately, there is little scientific information available regarding establishing transplants in the harsh upland prairie environments of the reservation. This research was initiated to provide information on Juneberry establishment and survival, taking into consideration the limited resources available on much of the land. The arid climate, relatively poor soils of the Fort Berthold Indian Reservation and the limited availability of water were evaluated using several of the available cultivars of *Amelanchier*.

Methods and Materials

Cultivars

Three cultivars selected for this study were Smokey, Martin, and Honeywood. They were selected primarily due to their proven success rates, vigor and fruit production (St. Pierre, 2005). They were also chosen because they are reliably available in large numbers in most years. A total of 1379 micro propagated Juneberries (434 Honeywood, 531 Martin, and 414 Smokey) growing in three inch by one and one half inch plastic pots, were purchased from Prairie Plant Systems, Incorporated of Saskatoon, Saskatchewan, Canada in 2004.

Site Descriptions

Fort Berthold Indian Reservation (FBIR) encompasses over 1.1 million acres of land. The reservation has a dry-sub humid, continental climate that is characterized by cold winters and warm summers (Brockmann et al., 1979). Reservoir Sacagawea, formed by the construction of the Garrison Dam, splits the reservation into the East side and the west side (See Appendix B). The East segments of the reservation are over 80% cropped with small grains and alfalfa. The physiography of the eastern segments consist of glacial landforms, loess deposits, windblown sands, glacial fluvial deposits, and recently formed alluvium bottom land (Brockmann et al., 1979). Soils on this east side were grouped into four large categories; glacial till, glacial outwash, and bottom land (Brockmann et al., 1979).

The west segments of the FBIR were markedly different geographically consisting of multiple river valley erosions into the Missouri River and present day Reservoir Sacagawea; only approximately 30% of the land area is used as cropland, with the remaining agricultural use being grazing. Soils on the western segments were classified or grouped according to soil depth, relief, and drainage. There were five general soil types described for this region. Shallow, nearly level uplands; moderately deep level to steep soils, on uplands; moderately deep, nearly level to strongly sloping soils on uplands and terraces; deep, nearly level to very steep soils on terraces, uplands and fans and deep, level to gently sloping soils on terraces, flood plains, fans, and uplands (Wright et al., 1982).

Three sites were selected for the study, one for each of the distant districts on the Fort Berthold Indian Reservation. Mean annual precipitation for all three plots was 14-16 in.(35-40cm.) and mean annual temperature is 40-42F (4.4-5.6C) (hprcc.unl.edu).

The White Shield plot was located in Section 12, T. 148 N., R. 88 W. of 5th Principle Meridian in McLean County at 47°38' North and 101°50' West. The plot was located on a glacial till moraine with a slope of 3 ±1%. Plants were located in a nearly level, concave swale on this site. The White Shield plot had been unused grassland located within the boundaries of the White Shield community. The plot size was approximately 25 meters wide and 75 meters long. This plot was identified as having Williams-Bowbells soil series (Brockmann et al., 1979). It had access to the local White Shield water supply. The White Shield site was well protected from the wind by a raised sewage lagoon on the north side, a tree row on the west side, and housing developments on the south and east sides.

The War Coulee plot was located in Section 5, T 148 N., R88 W. of 5th Principle Meridian in McLean County at 47°42' North and 101° 50' West. This site was located on a glacial till moraine with a slope of 3 ±1%) near the crest. The War Coulee plot had been cropped in small grains for multiple years with indications of average application of chemicals, both fertilizers and herbicides. The dominant soil series in this plot was Willams- Bowbells (Brockmann et al., 1979). The plot size was 25 approximately meters wide and 75 meters in length. War Coulee site was located sixteen kilometers west of White Shield on individually-owned Indian land. The land was donated by a local Tribal Elder. The site was irrigated with White Shield water. The War Coulee site was very

susceptible to wind as it had no protection and was on a terrace. Both the White Shield and War Coulee sites were located on the east side of the reservoir in the White Shield District.

The third site was known as the Mandaree site. The Mandaree plot was located in Section 1, T. 149 N. R. 93 W. of the 5th Principle Meridian in Dunn County at 47°41' North and 102°38' West. The plot was on glacial till moraine with a slope of 3 ±1%). The Mandaree plot was located along the crest and had been utilized as pasture. Its size was approximately 25 meters in width and 75 meters in length. The dominant soil series was Cabba-Cohagen Rhoads (Wright et al., 1982). It was located nine kilometers east of the Mandaree village on Indian owned land donated by the owner. The Mandaree site was unprotected from the wind and was also on a slight terrace. The Mandaree site lacked a water supply for irrigation, although some water was trucked in during the first year.

Soil Analyses

A total of seven soil samples were taken from the three sites. Two of the samples came from the Mandaree plot, two from the White Shield plot, and three from the War Coulee plot. Samples were collected from each end of the plots. An additional sample was taken at the center of the War Coulee plot, due to the minimal Ap horizon thickness. Samples were air-dried. For sample collections, a standard cutaway method was utilized. A small pit approximately 0.5 m across and 1.0 m deep was dug at each sample location. Due to the small size of the plots, similarity of the landscape, vegetation, and soil survey

maps of the three sites, this minimal analysis provided an adequate evaluation of the soil differences.

A portion of each sample was sent to the Pedology and Soil Chemistry Laboratories in the Plant Science Department at South Dakota State University for analyses. Soil particle size, aggregate stability, color, and selected chemical analyses were made by the laboratory using the modified procedures based on the methods developed by the USDA-SCS (Malo & Doolittle, December 2000) (Malo & Doolittle September, 2000) Determinations of the organic matter content, pH, NO₃-N, Olsen P, and K amount of each sample was also made. Soil texture classification was determined for each sample. Soil analyses data were evaluated to assess the similarities and differences between and within locations results.

Planting

All three sites were fall plowed and disked in October 2003 in preparation for Spring 2004 planting. Juneberry planting commenced on May 26 and was finished on May 27, 2004. All seedlings were of comparable vigor at approximately ten to twelve centimeters in height with two to four branches and were well leafed. All seedlings were placed in a hole slightly deeper than rooting mixture depth, filled in with soil, tamped in by foot, and then one gallon of water was applied to each seedling.

The three cultivars were planted in 3 rows with alternating replications of thirty-three plants at White Shield. The cultivars were planted in 3 rows with alternating replications of thirty plants at War Coulee and 3 rows with alternating replications of nineteen plants at Mandaree. The White Shield site had one hundred thirty two plants in

each row. Each row consisted of four replications of cultivar types with one cultivar type being duplicated in each row. The War Coulee site consisted of rows of one hundred twenty plants each while the Mandaree site had fifty seven plants in each row. At these sites each row also consisted of four replications of different cultivars with one cultivar type being repeated in each row. All rows at each site were numbered and labeled using PVC stakes. Each plant received one gallon of water on the day of transplanting.

Drip irrigation systems were installed within two weeks of planting at the White Shield and War Coulee sites, utilizing thick-walled half-inch tubing and emitters. The irrigation systems consisted of one half inch blue stripe plastic tubing laid on the ground near the seedling stems for the full length of each row. One gallon of water per hour emitters were installed at two meter intervals. This placed the emitters in between two plants. The water was applied for two hours every Wednesday and Saturday, unless there had been a substantial rainfall event. The systems were manually operated providing approximately one half gallon of water per plant at each watering period.

Water was provided to the White Shield site through a community watering system that provided potable. The War Coulee site's water source was a one thousand gallon tank for the 2004 planting season. In July of 2005 water was piped into the site. No watering system was installed at the Mandaree site.

Soil moisture readings were made bi-weekly for the first month. Precipitation data from the National Weather Service regarding the Fort Berthold Indian Reservation area was monitored and recorded for each site.

Plant Attrition and Vigor

Plant attrition and condition data were collected in September of 2004, Spring and Fall 2005, and Spring 2006. Final survey of plant attrition and plant vigor index measurements were conducted on each plant at all three sites between September 14 and 20, 2006. Attrition for the cultivars and locations were determined by counting the number of plants living on a given day for each replication at each site. The plant vigor index formula was generated by multiplying the number of stems on a plant, by the number of branches on the tallest stem, and the height of the tallest stem.. This value was found to provide an acceptable representation of the total plant mass, with regard to the variations in growth patterns that were observed (e.g. a short plant with multiple, mostly simple shoots vs. a tall plant with one or a few highly branched stems).

Additional plants were added to the sites to replace those from the first planting that had died. Although these plants were monitored, they were not included in these analyses.

Statistical Analyses

Normality of distribution of the data, analysis of variance and multiple comparison of means with the Tukey-HSD test were conducted using SYSTAT 12 statistical analysis package (Systat Statistical Software, San Jose, CA)

Results

Soil Analyses

The results of the particle size, chemical and physical characteristics analyses demonstrated that the soils from all three plots were largely similar, with only minor

differences. Most of the soil samples were texturally classified as a loam soil (See Appendix F). Soils from Mandaree SE, War Coulee 2, War Coulee 1, and White Shield 2 were some variant of clay loam. The Mandaree SE 4/5 site was a fine sandy loam and had significantly higher sand content than the other sites. The War Coulee 1 B site was a gravelly clay loam. The texture analysis of the soils was the primary factor creating the variation of the soils from the three sites. (See Appendix F).

The soil organic matter and mineral content analyses revealed few significant differences with the exceptions of low organic matter in the War Coulee 3 sample and high nitrogen and phosphorus content in the White Shield 1 Ap+ AB sample. War Coulee 1 B showed the highest mineral content in general in nitrogen, phosphorus and potassium, probably due to fertilizer applications made during its prior agricultural use (Appendix F).

Water Availability

Water availability is a problem across the reservation. Soil moisture measurements were made at all three sites throughout the summer of 2005. Precipitation data for the area from the National Weather Service was collected throughout the experiment (Table 1).

Table 1: Monthly and annual precipitation for North Dakota weather stations near Juneberry plantings. Data provided by Western Regional Climate Center (2008)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
Mandaree ¹													
2004	1.23	0.26	0.68	0.38	2.64	1.93	1.22	1.06	1.8	1.98	0.12	0.51	13.81
2005	0.64	0	1.27	0.02	3.8	6.9	1.79	0.75	0.49	1.22	1.08	0.33	18.29
2006	0.29	0.71	0.48	1.94	2.84	2.23	0.45	1.95	1.5	0.47	0.23	0.56	13.65
2007	0.22	0.79	1.12	1.07	4.07	1.39	0.83	1.18	0.56	1.37	0.24	0.08	12.92
War Coulee and White Shield ²													
2004	0.93 a	0.43	1.06	0.62	2.39	2.10 h	2.51	3.31	0.51 a	1.39	0.13	0.26a	13.54
2005	0.00 z	0.00z	0.83	0.32	4.16	11.8 6	1.13	1.75	1.28j	1.19	1.21	0.27	22.72
2006	0.03 0.21	0.27 0.48	0.32	1.91 c	1.2	1.43	2.24	2.94	1.38	0.78	0.06c	b	13.11
2007	a	b	1.17	1.09	7.82	4.42	1.56	2.09	1.31	0.14	0.14	0.16	20.59

1. Watford City - N 47.80 - W103.29 nearest data collection site to Mandaree (within 20 miles)

<http://www.wrcc.dri.edu/cgi-bin/cliMONtpre.pl?nd3376>

2. Garrison INNW - N 47.65 - W101.42 data collection site within 20 miles of both War Coulee and White Shield (<http://www.wrcc.dri.edu/cgi-bin/cliMONtpre.pl?nd9233>).

Plant Attrition

The total number of seedlings planted for the study was 1379 seedlings. There were 414 Smokey, 531 Martin and 434 Honeywood plants installed initially. These were divided by site with 529 at White Shield; 455 at War Coulee, and 352 at Mandaree. The total attrition was 243 or 17.6%. By cultivar, total attrition for Martin was 73 plants (13.7%), Honeywood was 54 plants (12.4%); and Smokey was 116 plants (28%). White Shield and War Coulee, which received supplemental water, did not show significantly different total attrition rates, but both had significantly lower attrition than the Mandaree site, which lacked facilities for supplemental watering (Table 2). The data also indicate that the Smokey cultivar tended to have higher attrition rates at all three locations, with significant differences at White Shield and War Coulee and a similar, but non-significant, trend at Mandaree, where all of the cultivars showed high stress levels (Table 2).

Table 2: Mean percent attrition \pm SEM of 3 Juneberry cultivars at three North Dakota locations on the Fort Berthold Reservation. (n= number of replicate plantings)

Cultivar	Mandaree ¹	War Coulee	White Shield
Honeywood	19.9% \pm 10.1 ^a n=7	8.4% \pm 2.2 ^a n=6	11.5% \pm 4.2 ^a
Martin	29.5% \pm 7.7 ^a n=8	4.7% \pm 1.2 ^a n=6	10.1% \pm 2.4 ^a n=6
Smokey	65.3% \pm 8.2 ^b n=6	11.4% \pm 2.4 ^a n=5	16.4% \pm 7.9 ^a n=5
Total Attrition for all cultivars²	36.5% \pm 6.3.1^x n=21	8.0% \pm 1.3^y n=17	12.5% \pm 2.1^y n=16

1. Cultivars having the same letter are not significantly different at $p=0.05$ within each location.

2. Total attrition for all plants at each location, having the same letter, are not significantly different at $p=0.05$.

Plant Vigor Index

The plant vigor index results are shown in Table 3. The overall combined average index for all three sites for the 1136 plants that remained at the final measurement in September of 2006. At White Shield the mean index was 1937 for the 463 remaining plants, at War Coulee the mean index value was 1341 for the remaining 419 plants and, at Mandaree, the index value was 431 for the remaining 254 plants. Comparisons of the location, cultivar and location by cultivar interactions showed that all were significantly different. Table 3 provides the values for all three comparisons.

Table 3: Mean Index of Vigor \pm SEM for 3 Juneberry cultivars at 3 North Dakota locations on the Fort Berthold Reservation. (n= number of replicate plantings)

Cultivar	Mandaree ¹	War Coulee	White Shield	Mean Index for each Cultivar over 3 locations ³
Honeywood	221 \pm 53 ^a n=7	668 \pm 119 ^a n=6	1406 \pm 255 ^a n=5	699 \pm 139^a n=18
Martin	664 \pm 120 ^b n=8	1721 \pm 251 ^b n=6	2423 \pm 163 ^b n=6	1509 \pm 195^b n=20
Smokey	368 \pm 63 ^{ab} n=6	1692 \pm 161 ^b n=5	1884 \pm 83 ^{ab} n=5	1255 \pm 187^{ab} n=16
Mean Index for all cultivars at each location²	432 \pm 66^x n=21	1341 \pm 161^y n=17	1937 \pm 145^z n=16	

1. Cultivars, within each location, having the same letter are not significantly different at $p=0.05$.

2. Index values for all plants at each location, having the same letter, are not significantly different at $p=0.05$.

3. Cultivars, across the 3 locations, having the same letter are not significantly different at $p=0.05$.

Analysis of the plant vigor indices, across all three environments, indicated that the Martin cultivar was significantly more vigorous than Honeywood at all three sites. They also performed better than the Smokey cultivar at the Mandaree site making Martin the overall best performing cultivar. The Smokey cultivar performed equal to the Martins with the exception of the Mandaree site, where there was a significant difference in the vigor indices for all three cultivars as compared to the two other locations (Table 3).

Discussion

Juneberries are capable of growing on a wide range of soil types and environments (St. Pierre and Tulloch, 2002). However, they tend to grow naturally in draws and along drainages where water is available much of the summer. Reestablishment of these plants on the uplands available on the Fort Berthold reservation requires finding plants that can adapt to this more-exposed habitat and survive transplanting in regions where water availability can be limited.

Few studies have examined the factors affecting transplant shock in woody plants, including Juneberry, and their influence on the establishment and survival of transplants. Rapid resumption of root growth is thought to be one of the principal processes responsible for plant survival after transplanting (Burdett, 1987; Ritchie, 1985), and water stress has been shown to have great influence on the morphological symptoms of transplant shock (Haase & Rose, 1993; Oliet et al., 2002).

Transplant shock has been shown to influence establishment and growth of ornamentals, fruits, and vegetables (Hartmann et al., 1988). Transplant shock has been used to describe the irregular period following transplanting when plants become

dormant. Little or no growth occurs during this time and plants are prone to death. Possible causes of transplant shock include poor root-to soil contact, soil water stress, and the developmental state of the seedlings at the time of transplanting. Weed management studies at North Dakota State University have had suggested that weed interactions with developing Juneberry plants can also effect transplant success. The results of these studies suggest that the effect of weeds may in part be due to their impact on soil water (Hatterman-Valenti, H. M. and Agnew, N. H., 1989).

The focus of this research was to establish what methods of planting and selection of cultivars would allow the reintroduction of Juneberries to the uplands of the Fort Berthold Reservation. Sites with and without available supplemental water were chosen to represent the conditions commonly found throughout the reservation. Commercial woven weed barriers were utilized to lessen the impact of weeds on the establishment of the seedlings. Limited irrigation was provided at sites where water was available and three cultivars were chosen, based upon availability and previous reports of their suitability for the harsh North Dakota climate (Hatterman-Valenti, H. M. and Agnew, N. H., 1989).

Cultivars

Honeywood, Martin and Smokey are 3 *A. alnifolia* cultivars developed the University of Saskatoon (St. Pierre, 1999). All three have similar growth characteristics, attaining a height of about 3 m and a spread of slightly less than 2 m. These cultivars usually flower in may and fruit ripens in June or early July. The fruit is considered to be of extremely high quality (Giesbrecht, 2004).

Because Junberry plant growth habits vary with environment, the vigor index was employed to estimate total plant growth. This index allowed quantitative comparisons between plants that had multiple stems and those with few stems that were multi-branched. In conjunction with attrition, this index allowed us to assess the overall performance of each of the cultivars. These two tools proved to be useful in discerning the differences in cultivar response to the variation in planting environments available on the Fort Berthold Reservation.

Environment

The seven soil samples taken from the three plots showed that there were strong similarities between the three plots. As expected, the soils were representative of the series indicated in the state Soil Surveys maps (Brockmann et al., 1979); (Wright et al., 1982). The White Shield and War Coulee plots were classified as Typic Argiustolls and the Mandaree plot was classified as Typic Ustorthents. The chemical and physical analyses of these soils confirmed the characteristics of these soil classifications (Malo, September, 2003).

A major difference between the three plots was the depth of the A horizon (Broderson, 1991). Depth of the A horizon at the White Shield plot was 30-45cm. The Mandaree plot's A horizon was 15-18cm in depth. The A horizon at the War Coulee plot was 7-12cm deep. The variations in the depths of the A horizon impact the productivity, water storage, quality, and permeability of the soils. In turn, these character differences and annual precipitation have direct impacts on the vegetation.

This analysis indicated that the soils of the three plots were similar in their characteristics and horticultural capabilities. Their differences did not constitute significant adjustments for agronomic use or production dependent upon other factors primarily precipitation and other climatic variables. The soils were largely similar in origin, physio-geography, climate, location, and suggested uses.

The three plots were similar for most other environmental components. Soils were well to moderately drained with moderate to moderately slow water permeability, even though the A horizons did show variation. Precipitation at all three locations is about 15.5 inches per year on average and varied significantly from year to year, during this study. May and June provided most of the natural water in 2005 and 2006. Supplemental watering of the War Coulee and White shield plots provided the major environmental difference between locations. Wind protection and its potential effects on evapo-transpiration provided the other environmental difference between the sites. The wind-break at White Shield afforded protection to the young seedlings that was not available at War Coulee and Mandaree. Water availability was therefore a primary concern for the reestablishment of Juneberries on the uplands of the Fort Berthold Reservation. The

attrition data clearly demonstrate this conclusion. Attrition rates were 3 to 4 times higher at Mandaree than at War Coulee or White Shield (Table 2), where water was supplemented.

The variation in attrition rates for the three cultivars showed that in addition to water, cultivar selection is important to seedling success rates. At Mandaree, where water was most severely limited, the Smokey cultivar had significantly higher attrition rates than did Martin or Honeywood. Furthermore, although not at a significant level, the trend for Smokey seedlings to suffer higher mortality than the other cultivars was noted (Table 2).

Assessment of the vigor indices for the three cultivars over the three locations further supports the conclusion that water is the most important factor for Juneberry seedling establishment on the Fort Berthold Reservation. At Mandaree, the vigor indices for all three cultivars was significantly lower than for plants at War Coulee or White Shield (Table 3). The potential benefit of planting behind a windbreak was also suggested by the vigor indices. The overall vigor was greatest at White Shield. It was even significantly greater than that of plants at War Coulee, where supplemental water was also applied, which implies that the windscreen may account for this difference.

The plant vigor indices at White Shield, War Coulee and Mandaree shows that the non-irrigated plants to have significantly fewer stems, branches and are short in height across all three cultivars. Results by cultivar show that the Honeywood cultivar was less vigorous than the Martin and Smokey cultivars at all three locations. These indices also show, that once the Smokey cultivar is establish, its growth is not reduced significantly as

compared to Martin. This result is consistent with previous cultivar studies (St. Pierre & Tulloch, 2002). However, with Smokey's significantly higher attrition rates, this is probably of secondary importance.

Recommendations

Cultivar selection is an important factor in the potential success of new Juneberry plantings on the uplands of the Fort Berthold Reservation. . The cultivars, Martin and Smokey both showed high levels of plant vigor especially at the sites where supplemental water was present. Both cultivars would be acceptable choices for individuals interested in private or commercial Juneberry production, especially in areas with ample water supplies. Honeywood plants are probably not a good choice for planting on Fort Berthold. There are also some remnant populations of *A. alnifolia* in drainages and other location on the Reservation. Selection and propagation of plants producing desirable fruits is in progress and perhaps some of these selections will prove more suitable to the climate.

Site selection on the upland portion of Fort Berthold is also of importance in assuring the success of new Juneberry plantings. Overall analyses of both the attrition rates and vigor indices showed the two sites which had available water also had the lowest overall attrition rates and the highest vigor indices for the Juneberries. These results indicate that it is technically possible to plant Juneberries in the absence of irrigation water, but to minimize attrition supplemental water is essential when transplanting Juneberry on the Fort Berthold Indian Reservation in Western North Dakota. A single watering at the time of transplanting is insufficient. Trucking of water

for several weeks would be beneficial in establishing a Juneberry plantation.

Furthermore, supplemental water can significantly increase the overall growth of the seedlings, as can the availability of natural windbreaks. These findings are supported by the data presented in Tables 2 and 3 and are consistent with existing literature recommendations (Hausher, June 2000).

The availability of water will probably also have significant impacts on fruit quantity and quality (Hausher, 2000). Evaluation of this factor to the overall success of commercial plants will require continued observations for the next 10 years. Continuing studies will serve to better understand the long term impacts of presence of water, soil, site, and cultivar on the very important variables of quantity and quality of fruit production. Establishment of commercial and private stands of Juneberries requires this additional information. The results of this study provide interested growers, on the Fort Berthold Indian Reservation, with information on how to minimize transplant attrition and to successful Juneberry establish plantings.

CHAPTER 3. TRIBAL ELDERS AND JUNE BERRIES ON THE FORT BERTHOLD INDIAN RESERVATION: PAST AND PRESENT PERSPECTIVES

Introduction and Background

The Mandan, Hidatsa, and Arikara (Sahnish) Nations have lived along the Missouri River for centuries. Historians and anthropologists have documented that the Mandan moved into the area of present day South Dakota about 900 A.D. and slowly migrated north to present day North Dakota about 1000 A.D. The Hidatsa moved from central Minnesota through eastern North Dakota and joined the Mandan along the Missouri River in the 1500's A.D. The Arikara Tribe lived for centuries in an area that extended from the Gulf of Mexico north to Kansas and South Dakota (www.mhanation.com/main/history/history_three_tribes, March 30, 2008).

The Mandan and Hidatsa Tribes belong to the Siouan linguistic group along with Crow, Dakota, Assiniboine and others. The Arikara belong to the Caddoan linguistic group along with the Pawnee, Wichita, Skidi, and others. For centuries the three tribes maintained separate villages. After the final small pox epidemic in 1837 and for protection against roaming bands of Sioux, the Mandan, Hidatsa and Arikara Tribes began living in near proximity to each other first at Like a Fish Hook Village, near present day Garrison, North Dakota. The three tribes were officially placed on the same reservation named Fort Berthold through the Fort Laramie Treaty of 1851. In the latter 19th century, they once again made a short migration north to live within the reduced lands of the Fort Berthold Reservation where they remain living today

(www.mhanation.com/main/history/history_three_tribes, March 30, 2008). During this timeframe (the fifteenth to nineteenth centuries) the MHA Nations also maintained a vast trading system that stretched to both the east and west coasts of the United States as well as to the Gulf of Mexico. The Mandan, Hidatsa, and Arikara Nations historically lived in earth lodges, maintained huge gardens, and hunted wild game, especially bison. In addition to the gardens and wild game, members of the Mandan, Hidatsa, and Arikara (MHA) Nations also relied heavily upon the indigenous plants of their environment for food, shelter, medicines, utensils, and weapons. One of the heavily utilized indigenous plants as a food source was the Juneberry (Transcript of Tribal Council and Federal Government Meeting at Elbowoods, May 27, 1946).

Research Objective

Juneberries were an integral component of the healthy diet practiced by the Mandan, Hidatsa, and Arikara people for centuries and until flooding of the fertile bottomlands due to the Garrison Dam (Conti, 2006). Today, many Tribal Elders reminisce about their lifestyle before the dam with frequent references to the harvesting and use of Juneberries (New Town News, Ogden, October 6, 2005). The purpose of this research was to provide documentation supporting these reported uses of Juneberries by the Mandan, Hidatsa, and Arikara people and to gain insight from elders on the historical and contemporary importance of Juneberries to the MHA tribal members. The specific questions addressed by this research were:

1. How were Juneberries used by tribal members prior to relocation in 1954?
 - a. Who used Juneberries?
 - b. What were Juneberries used for?
2. Where were Juneberries found prior to relocation?
3. What factors influenced the availability of Juneberries prior to relocation?
4. How are Juneberries used by tribal members in 2006?
 - a. Who uses Juneberries?
 - b. What are they used for?
5. Is there interest among tribal elders to expand Juneberry production on the Fort Berthold Indian Reservation today?

Research Methods

The researcher utilized qualitative methodologies to explore these research questions. According to Crazy Bull (p. 18, 1997) “qualitative research is more compatible with the traditional Indian way of knowing. It is holistic. It seeks to describe and understand rather than to test hypotheses.” Another consideration in choosing a qualitative approach was the probable size of the sample of tribal elders. It is estimated that there are fewer than 100 MHA tribal elders alive today who resided on the bottomlands prior to relocation. Factors such as elders' health, transportation, and accessibility to the researcher limited participants to twenty-one completed interviews and surveys. In addition, documentary and archival data, provided for data triangulation and additional insight on research questions (Brewer & Hunter 1989). The researcher also employed participant feedback by having two tribal elders provide feedback and discussion for verification and insight on survey and interview results (Johnson, 1997).

Methods and Materials

Subjects

Interview subjects were twenty-one Mandan, Hidatsa and Arikara (MHA) elders who agreed to participate in the interviewing process. Their voluntary participation was requested at small group gatherings such as Elder Group meetings or community meetings and through individual inquiries by the researcher. Some subjects were identified through referrals from other participants and from family members whom the researcher contacted. All interviewees had resided on the Fort Berthold Indian Reservation prior to the 1952 flooding of their homelands caused by the completion of the Garrison Dam and the resulting Garrison Reservoir now known as Lake Sacagawea. Subjects were between four to sixteen years of age in 1952, between sixty and seventy-six in 2007, and were nearly evenly divided, male to female.

Interview Guide/Cover Letter

All interviews began with an explanatory introduction. The subjects were asked to participate, informed of the purpose, assured that their responses were voluntary and would be kept anonymous and confidential. Out of respect for the elders' age and experiences and to minimize stress and imposition upon them, the elders were given the option to write their own responses to the questions, have the researcher transcribe responses for them, or have their interview tape recorded. Seventeen of the interviewees chose to write their own responses and four chose to be interviewed. Follow up questions were asked to clarify original responses. Only two of the interviewees allowed their interviews to be tape recorded. At completion of the interviews, subjects were informed

of how to obtain the discussion of the findings in keeping with cultural protocols. Participants were offered a small thank you gift for their participation in the study.

Research Instrument

The twelve questions on the interview guide were developed to address the research objectives. The research instrument was developed, field tested, and refined during the author's graduate course in Qualitative Research Methods during Spring 2005. The research project and the instrument were reviewed by the Fort Berthold Elders Council due to the lack of an institutional review board at Fort Berthold Community College and because the intended research involved MHA elders. Participation in the research project was at the discretion of individual MHA elders. Questions explored subject's knowledge about Juneberries gathered and used by the members of the MHA Nations before the forced relocation from the flooded bottomlands, the extent of current use by subjects and their families today, and current interest in increasing availability of Juneberries.

All questions were refined to solicit short clear responses although some interviewees expanded on their answers. All interviews were conducted in English although many of the elders injected their Tribal language word for Juneberries (Arikara- naca nahnu; Hidatsa- Ma-dsu-da-ba; Mandan- Mawna Boosh-a-geh). They were asked similar questions about the past and the present regarding Juneberry usage. In the first half of the interview, the questions asked whether the interviewees helped pick Juneberries as a youth and if so they were asked to explain location of the berries, with whom, and the Juneberries were used for. In the second part of the interview subjects

were asked similar questions about their present day picking habits, uses of Juneberries and about their interest in expanded contemporary availability of Juneberries.

Interviews

All interviews were conducted with MHA tribal elders from the Fort Berthold Indian Reservation between March 2005 and October 2007. A majority of the interviews were completed in 2006. Interviews took place in a private setting in the elder's home, the elder's office, the researcher's office, or another private room. The majority of the interviews were conducted in the various elders' homes. The interviews were conducted in a friendly atmosphere with other conversations of various themes preceding and/or following all interviews. Most interview sessions involved the researcher and subjects sharing some drink or food, ranging from coffee or water to a complete meal either before or after the interview. The vast majority of the food and drink was provided by the interviewee. In keeping with MHA tribal traditions, the researcher offered gifts of tobacco with money, meat, or a blanket.

Results

The questions addressed by this research were:

1. How were Juneberries used by tribal members prior to relocation in 1954?
 - a. Who used Juneberries?
 - b. What were Juneberries used for?
2. Where were Juneberries found prior to relocation?
3. What factors influenced the availability of Juneberries prior to relocation?
4. How are Juneberries used by tribal members in 2006?
 - a. Who uses Juneberries?
 - b. What are they used for?

5. Is there interest among tribal elders to expand Juneberry production on the Fort Berthold Indian Reservation today?

Questions number one through six on the interview guide explored how Juneberries were used by the MHA Nations prior to the relocation in 1954. Question one asked if the subject had ever gathered or used Juneberries when they were young. One hundred percent of the respondents (n=21) indicated that they had helped gather or use Juneberries when they were young.

Responses to this question included one elder saying, "I was seven years old when we picked Juneberries in Nishu". Another woman said, "All [us] girls-my sisters and I, went Juneberry picking each summer". Still another offered, "My family and I lived in Elbowoods, and as a little girl my sisters and I would help our mother pick Juneberries". And another respondent stated, "Our mother made pudding, pies, jelly, etc out of them. They were a part of our diet. She would also can them".

Common uses included puddings and pies (n=5), dried (n=4), and both canned and cornballs (n=3) and others/none (n=6). Respondents shared their uses in this question also. One elder said, "We used to dry, pick just to eat fresh, make a pudding they called Juneberry pudding. We made patties, pudding, pies, bread, cupcakes, and dried some for the winter".

Research question two explored where the Juneberries were usually found prior to relocation. Responses (n=21) indicated that the most common sites were coulees and draws (n=17), side hill (n=9), riverbanks and beside water (n=8). Qualitative responses included:

“Nice round Juneberries were found along the hill sides and coulees” said one elder.

Another offered, “We found them in a coulee, and river banks mainly where water was available”.

Research question three asked what other plants were located in proximity to the Juneberries. Responses (n=21) were other berries, plums and grapes (n=12), trees (n=5), and poison ivy and poison oak (n=3). One respondent shared that “Choke cherries, wild plums, and gooseberries grew near Juneberries”. Another recalled that Chokecherries, bull berries and wild turnips grew close to Juneberries”. Still another added, “Sometimes we dug up wild turnips near where we picked Juneberries”. Still another elder offered, “Also found a rare tree patch, which I later discovered was wild raspberries. Unfortunately this patch of wild raspberries was on private land and was unable to see if this patch still exists”.

Research question four asked subjects to describe what factors impacted Juneberry bushes. Responses (n=20) were late winter or spring frost (n=17), insects (n=10) and deer (n=7). One said, “A late frost sometimes affected the bushes, I don’t recall times where we couldn’t or didn’t find Juneberries they were usually plentiful!” Another mentioned, “Deer, winter, heavy frost and drought-these are some of the things I remember”.

Research question five asked the subjects to describe factors that affected the berries themselves. Responses (n=21) included late frost (n=12), wind (n=10), birds (n=8) and dry spring (n=7). One respondent stated the following, “An early spring or late

frost combination would once and a while affect the crop, but there was still a crop to pick.” Another elder added said, “Cut worms.” Still another told the researcher, “Late frost would kill the berries, also a late snow, drought, and dry spring”. Most others agreed that the Juneberries were plentiful prior to relocation.

Research question six became an extension of question one and as a result most of the responses (n=21) were repetitive, but did provide clearer answers. The question asked the subject how they used the Juneberries. Responses were fresh/pudding (n=19), dried/cornballs (n=15), canned (n=6). One respondent offered that their family used Juneberries in the following ways, “Fresh when picked, in cornballs, cookies, and pudding. They also dried some for winter, storing the dried berries in a flour sack or a cookie can.” Another elder added, “My sisters and I would eat the Juneberries as a snack and we would watch my mother make cornballs out of them”. Still another said, “We canned the Juneberries a lot for use in the winter. Mother would make pudding, pies, or we would just eat as a sauce. The sauce was good alone or as a topping on pancakes-the best!”

The second set of research questions one through six explored how subjects presently use Juneberries. Question number one asked whether or not you or your family pick Juneberries now. Responses (n=19) were yes (n=7) and no (n=12). One qualitative response was, “Yes I pick Juneberries when there is any”. Another elder told, “Yes, but we can seldom find them. This year we couldn’t find any.” A third subject stated, “No, I haven’t seen a Juneberry tree produce enough Juneberries to harvest in the past three

years”. One final comment was, “No, where we used to pick is under water at Lucky Mound”.

Research question two asked if they or their family did not pick Juneberries, why not. Responses (n=12) were no Juneberries/hard to find (n=8), fences/access (n=3), poor health/don’t know (n=3). One respondent stated, “Don’t live in the country so they are not readily accessible.” Another said, “Family doesn’t like picking berries because there are no Juneberries around anymore” A third subject said, “We can’t get to them, other people’s land”.

Research question three asked respondents if they or their families do pick Juneberries currently, then why. Respondents (n=8) stated tradition (n=5) and food/nutritious (n=3). One elder remarked, “My grandchildren love picking them, just as I did when I was young. They are good health wise.”

Research question four asked subjects how they use Juneberries today. Responses (n=17) included fresh/pudding (n=9), frozen/bought (n=6), and cornballs (n=6). One Elder shared that she got her Juneberries “From the supermarket, either fresh or frozen”. Another subject said, “Usually fresh.” Still another added, “Today I usually get the Juneberries from Walmart, which they sell in their frozen food section as “wild blueberries” for (\$11 or so). We use them for “wojapi” for funerals, feasts, and traditional meals”. Another commented that she ate them with her breakfast cereal.

Research question five asked respondents to discuss the differences between Juneberries now and when they were younger. Responses (19) were gone/flooded/no trees (n=11), and smaller bushes/berries (n=6). One Elder stated, “Most of where we used

to pick is underwater”. Another one said, “There are hardly any berries these days.” A third respondent shared, “It’s pretty frustrating when we go to pick and we can’t find any.” One woman said, “Juneberries are harder to find. It seems those roads, farming, grazing, and the way weather patterns have changed has caused the crop to vanish.” A final respondent shared, “The timber by the Little Missouri is gone; it is all under the lake”.

The last question in the interview asked subjects if they would like to see Juneberries more available on Fort Berthold today and why. Responses (n=21) included yes (n=20) and no (n=1). Responses to the reasons portion of the question were old ways/tradition (n=8), for the people/younger generation (n=8), easier to get (n=7), and for memories (n=6). One elder stated, “Yes, certainly because Juneberries are a traditional food for our people. I think most people would be happy to pick Juneberries again. It was a beautiful family outing at one time. [Us] little ones had little lard pails that we used to help pick. We all emptied our pails in the big galvanized tub when they were full”. Another stated that she “Would like to see Juneberries again like it was before we all got flooded.” One respondent said, “If they were easy to get at that would be even better. We’re old - you know!” Yet another said, “Because that’s all we used to live on...that was our ‘sweets’”. Finally one commented, “Because picking Juneberries would always remind me of my sisters and mother and I long for those simple days. Today everybody is too busy”.

Reliability and Validity

The researcher utilized synchronic reliability from an etic perspective. The synchronic reliability was established through the similarity of the numerous observations obtained within the same time period from a variety of Tribal Elders who grew up on the Fort Berthold Indian Reservation during the era preceding the flooding due to the Garrison Dam. To ensure the validity of responses, as a non-Tribal member, the researcher's perspective might be considered derived emic (Glaser & Strauss, 1967) due to the fact that the researcher has resided on the Fort Berthold Indian Reservation for over thirty years and has been adopted by a family and "brought into" several Tribal societies. The researcher has also worked with native plants, traditional gardens, and teaching and research projects throughout the Fort Berthold Tribal Community College. Thus, he is able at least partially understand the subjects' reality from their perspectives. In a further attempt to strengthen the validity of the research, methodological triangulation was employed.

Results from interviews were compared with documentary data such as quotations regarding Juneberries from Buffalo Bird Woman, a famous Hidatsa gardener and historian, cited in the unpublished notes of Gilbert Wilson, an early 20th Century ethnographer who visited the Hidatsa villages yearly for over a decade, government committee hearings (U.S. Senate Committee on Indian Affairs, October 9, 1945), and cultural workshops (Juneberry Workshop Transcript, 2003). The results of this comparison between interview statements and documentary data indicated that qualitative

reliability was achieved, thus interview results were verified as plausible, steady and confirmable.

Discussion

The results of this research project support and document previous literature regarding the historical use of Juneberries by the members of the MHA Nation and the decrease in both availability and use of Juneberries since the relocation of the members of the MHA Nation due to the flooding of their Missouri River Bottom Homelands. The results from the first section of the interviews clearly indicate among the participating Elders, harvesting and use of Juneberries was common practice prior to the flood. These findings support all the historical and archival data, which reported Juneberry use by the Tribes for centuries (Gunderson, 2003). The results also document the social and cultural aspects involved with Juneberry harvesting and preparation. The numerous statements by the participants regarding time spent with their mothers and sisters picking and preparing Juneberries reinforce the statement as due the numerous comments regarding their wishes to be able once again to participate in these types of activities. For example, the responses regarding harvesting and use of Juneberries prior to the flood also strongly corroborate that Juneberries were an integral component of the healthy diet practiced by the Mandan, Hidatsa, and Arikara people for centuries and until flooding of the fertile bottomlands due to the Garrison Dam (Conti, 2006; Transcript of Meeting at Elbowoods, May 27, 1946; U.S. Senate Committee on Indian Affairs, 1945; Van Develder, 2005).

Responses from the second half of the interview guide also provide insight regarding the extent of the impact of the Garrison Dam flood upon not only Juneberry

use, but the entire way of life of the members of the MHA Nation. Quotes regarding the flooding of the bottomlands and the bushes being gone are indicative of the change in environment and lifestyle resultant of the flood. The responses for questions concerning the present uses of Juneberries are strongly supportive of the comments made during the Juneberry Workshop and the Voices from the Bottomlands conducted at Fort Berthold Community College (Juneberry Workshop Transcript, Fort Berthold Community College, November 5, 2003; Echoes From the Bottom Lands: Tribal Voices on Garrison Dam, Public Meeting, March 24, 2006.) One Elder's statement summed up the feelings of the group by saying, "I have not seen a Juneberry tree produce enough berries to harvest in the last three years, so we thought better to let them continue to grow and bring more berries in coming years". Another stated, that when available, "We eat them fresh, make cornballs, and jelly out of them". In general this statement summarized their responses, "Where we used to pick Juneberries is under water due to the Garrison Dam. We buy them now from someone who is selling Juneberries".

Many of the responses to the final question regarding the increased availability of Juneberries also reveal not only the impact of the flood, but many of the Elders' wishes for the reestablishment of some portions of their social practices that were destroyed by the flood. These quotes strongly reinforce the wishes of the participants in the NRE Talking Circles regarding the wishes for vigorous programs to reestablish Juneberries on the Fort Berthold Indian Reservation (NRE Talking Circle Transcripts, November, 2001). For example one participant said, "If everyone dedicated even a small amount of time to ensure Juneberry survival, we also in turn help preserve a part of our own history. With

all the organically grown foods in such demand now, did anyone even think that the foods of yesteryear needed improving?" Another one said, "I enjoy picking them it brings back memories of long ago".

In summary, this research provides information documenting the use of Juneberries and other wild fruits historically by the members of the MHA Nations, the greatly decreased use of Juneberries in the present day as a result of the flooding and relocation, and finally the a high level of interest in expanded availability of Juneberries among the Tribal Elders of the MHA Nation.

Summary of the Results

Elders were interviewed about their uses of the Juneberries prior to the construction of the Garrison Dam, their present day uses, and their interest in increased availability of Juneberries on the Fort Berthold Indian Reservation. The responses to the survey questions are summarized in Tables 3 and 4.

Table 4: Historical Uses of Juneberries by Elders on the FBIR

Question	Responses	N
1a. Gathered:	Yes	21
	No	0
1b. Uses:	Dried	4
	Pudding/Pies	5
	Canned	3
	Bread/Cornballs	3
2. Area Found:	Coulee/draws	17
	Side hill	9
	River banks/beside water	8
3. Plants Nearby:	Other berries, plums, grapes	12
	Poison Ivy/Poison Oak	3
	Trees	5
4. Affected Bushes:	Late Winter/Spring Frost	17
	Deer	7
	Insects	10
5. Affected Berries:	Wind	10
	Late frost	12
	Birds	8
	Dry spring	7
6. General Uses:	Fresh/pudding	19
	Dried/cornballs	15
	Canned	6

Table 5: Present Uses of Juneberries by Elders on the FBIR

Question	Responses	N
1a. Gather:	Yes	7
	No	12
2. Reason No Gathering Occurs:	No Juneberries/hard to find	8
	Fences/access	3
	Poor health/don't know	3
3. Reason Gathering Occurs:	Tradition	5
	Food/nutritious	3
4. Uses:	Cornballs	6
	Fresh/pudding	9
	Frozen/bought	6
5. Differences between Then and Now:	Gone/flooded/no trees	11
	Smaller bushes/berries	6
6a. Desire for Increased Availability:	Yes	20
	No	1
6b. Reasons for Wanting Increased Availability:	Old ways/tradition	8
	Easier to get	7
	For memories	6
	For people/younger generation	8

Summary

The results of the interviews provide documentation that the members of the Mandan, Hidatsa, and Arikara Nations gathered the Juneberry and utilized them extensively when they lived on the Missouri River bottom lands. One hundred percent of the interviewees reported picking the Juneberries and eating them in multiple fashions as well as drying and canning them for future use. Results reflect the dramatic change that occurred in Tribal diet and lifestyle after the flooding and forced relocation to the present day reservation lands. Only seven of nineteen Tribal Elders reported that they or their family members still pick Juneberries. The reasons stated for this included that there were no Juneberries; they were very hard to find; or that they were inaccessible. The interviews did indicate that participating Elders still obtain the Juneberry, from commercial growers or grocery stores. These results support the belief that Juneberries were an important part of the culture and diet of this sampling of Elders of the members of the MHA Nations. Finally, the interviewees indicated almost unanimously that they would like to see Juneberries made more available on the Fort Berthold Indian Reservation. Reasons for this ranged from “old ways/traditions” to “they’d be easier to get” to “for the people” and “for the youth”.

Implications

Examination of the results of this research provides insight into both culture and lifestyle of the MHA people when they subsisted off of the land along the Missouri River. The results also show indications of the upheaval and alteration of lifestyle resultant from the forced relocation after the flooding. The qualitative methods used included

participatory responses, interviewing, documentary data, and participant feedback regarding results. These methods were employed successfully to provide valid and reliable information regarding the subject matter as stated by Cheryl Crazy Bull (1997) that qualitative methodologies work best with Indian people. Similar techniques and processes could be used by other researchers to investigate topics relative to Tribal Nations' history and culture. Results suggest strong interest and potential value of the reintroduction of Juneberries on the Fort Berthold Indian Reservation. There is potential for this reintroduction of Juneberries to improve the diet, nutrition and wellness of the MHA people along with keeping alive cultural traditions and strengthening connections among the generations.

Suggestions for Future Research

Additional studies need to be conducted regarding the changes in nutrition habits among the members of the MHA Nation from before the flood to the present. These studies could provide valuable insights into possible dietary changes that could be employed using traditional foods to combat obesity, diabetes, and heart disease. Studies could also be conducted to evaluate the relationship between the MHA youth and the natural resources of the Fort Berthold Indian Reservation. Results of surveys and interviews of Tribal youth could provide information regarding which areas where MHA youth have needs to improve their understanding of the natural world around them. The next section of this paper suggests a plant-based framework for increasing the awareness of not only the MHA Nation, but all Tribal youth regarding historical uses of plants by their indigenous ancestors.

CHAPTER 4. PLANT BASED CURRICULUM FRAMEWORK

Introduction

As part of the effort to develop and implement curricula to perpetuate Native culture and language and promote academic success a plant-based curriculum was developed for use in a Tribal College or a school located on a reservation. The chapter includes general examples for implementing the activities drawn from the local community, the local ecosystem and specific examples from the author's program. The researcher next presents a plant-based curriculum framework for educators, using local plants for lesson topics ranging from botany to anatomy and history while adding culturally relevant pedagogy to the curriculum. With the exception of an instructor being an enrolled member of the local Tribal Nation who is also well versed in the traditional ecological knowledge and culture of his/her Tribal Nation the framework requires an instructor to receive assistance from a Tribal Elder or cultural advisor willing to assist with the culturally relevant plant information as well as the assistance of a resource person or expert in the local botany.

Humans have used plants for multiple purposes throughout human history. For thousands of years, plants have provided shelter, food, tools, weapons, and medicines for humans around the world. Plants have played a part in human social structures, economies, politics, and histories, especially as crops and medicines. Many indigenous people retain Traditional Ecological Knowledge (Cajete, 1994) about histories of and uses for certain plants within their native regions.

Culturally-based Education

Improving Native students' learning, interest, and motivation through the inclusion of language, materials, and subject matter that is culturally related to the Native student to improve performance is not a new or original concept (Demmert & Towner, 2001). The inclusion of native culture and language was first recommended by the Merriam Report of 1928. Inclusion of culturally relevant curriculum for American Indian and Alaska Native learners has repeatedly been urged according to Demmert (2001) and Cajete (2000). The proposed plant-based framework incorporates a holistic cross-cultural pedagogy, which incorporates an inter-relatedness approach to science (Cajete, 2000). Inclusion of community and respectfulness toward cultural traditions is also stressed in this framework as another method for improving the academic performance of American Indian/Alaska Native student (Peacock, 2002). Implementation of the methods and processes suggested here satisfy the six critical elements of cultural based educational curriculum as defined in the *Review of the Research Literature on the Influences of Culturally Based Education on the Academic Performance of Native American Students* (Demmert & Towner, 2003). These elements are

1. Recognition and use of Native American (American Indian, Alaska Native, Native Hawaiian) languages.
2. Pedagogy that stresses traditional cultural characteristics, and adult-child interactions.
3. Pedagogy in which teaching strategies are congruent with the traditional culture and ways of knowing and learning.
4. Curriculum that is based on traditional culture and recognizes the importance of Native spirituality.

5. Strong Native community participation (including parents, elders, other community resources) in educating children and in the planning and operation of school activities.
6. Knowledge and use of the social and political mores of the community.

Essential Characteristics

The plant-based curriculum framework is designed to be adapted to different habitats, ecosystems, and reservations. It is also flexible enough for addition to or deletion of individual activities or applications. None the less, there are certain ingredients to the model that the author believes are necessary for the model to have maximum effectiveness. The characteristics grew from those of a place-based teaching model developed by Semke (2005) combined with the critical elements of culturally based education listed above.

1. **The plants and human resources utilized must be native to the area.** FBCC students learned taxonomy, botany, research methods, native languages, and more while also learning about their own local habitat, history and customs (See Appendix G). FBCC students have produced multiple pages of plant related and Tribal custom words (See Appendix T).
2. **Lessons must include multiple uses and roles of the plants studied-historically and contemporary.** FBCC students learned how the plant was used by their ancestors, through the multiple levels of the animal kingdom, and that plant's niche in the local ecosystem. Methods employed ranged from literature reviews to interviews (See Appendix I). FBCC students added to their existing knowledge a broad view of human and environmental uses of plants. Fort Berthold Indian Reservation Elders and other community members were included to share expertise, stories, and recipes (See Appendix H).
3. **Lessons must include horticultural activities and field experiences.** FBCC students went into a natural setting to experience their environment and the plants being studied (See Appendix O). Students experienced horticultural practices ranging from germination and growing to harvesting and use of real plants (See Appendix N). Ethnobotany students participated in activities

ranging from germination labs to transplanting sprouted seeds and carrying for plants until maturity and harvest. In Research Methods, FBCC students assisted with transplanting Juneberries, Willows, and the other forty indigenous plants for in the Nature Park. Models or drawings of plant parts, products labeled in their native languages adorn bulletin boards and walls of the Science wing at FBCC.

4. **Lessons explain, support and promote sustainable uses of plants and the ecosystem.** FBCC students assisted in their development of the attitudes and practices necessary to minimize modern society's impact on the plants and habitat of their local reservation ecosystem. Problem-based activities and alternative perspectives were presented for consideration of various impacts on community and ecosystem. This was accomplished through field trips to Cross Ranch Nature Preserve and Theodore National Park where students, faculty and Elders were presented information on native environments undisturbed by modern agriculture or human impact. Students were then taken to similar ecosystems that had been altered by human impact including agriculture. Through discussion groups and written reflections students discussed the differences between the two sites. Emphasis is placed on historical lifestyles of the Mandan, Hidatsa and Arikara people of that and neighboring areas. To increase FBCC students' understanding of the historical lifestyle of the Mandan, Hidatsa, and Arikara people students complete a time line activity in either in small groups or individually utilizing the Mandan, Hidatsa, and Arikara website, Fort Berthold Community College Cultural Advisors, library resources, and Elders. Students include migrations, villages, epidemics, laws and treaties, Congressional Acts, and other events in their time lines (See Appendix R).
5. **Lessons and outcomes enrich student, instructor, and community with ethnobotany of local plants.** FBCC instructors and students gain cultural and historical knowledge from Elders, community members, students, and activities along with some linguistic skills in the local indigenous language (See Appendix S). In Ethnobotany, FBCC students regularly bring family members to assist with their presentations on their cultivated and or gathered edible plant products. Family members assist students in their explanation of food preparations and contents including Mandan, Hidatsa and Arikara customs and languages. FBCC students share their ethno botanical knowledge and course products with their families and their community (See Appendix P). Multiple FBCC classes as well as the SEEDS and AISES Clubs were involved in designing and planting a nature park on FBCC's Cultural Center Grounds. The park included over twenty varieties of native trees and shrubs including Juneberries, Chokecherries, Bull berries and grapes. Students learned the niche of all plants involved in their native ecosystem. All involved

gain interest in lifelong learning about ethnobotany (See Appendix U).

6. **Curriculum framework is based on Traditional culture and Native spirituality.** Instructor is assisted throughout the curricular model through input and participation from local community members or MHA Elders (See Appendix S). FBCC staff includes two full-time cultural instructors in addition to numerous part-time language and cultural instructors. These individuals regularly appear as advisors on field trips or as guest speakers to enrich classroom activities. FBCC students receive advice and information from the cultural advisors in response to inquiries regarding explanations of MHA nations, historical and current beliefs and practices regarding plants, soils, water, weather, and all aspects of ethno botany. Names of plants, the parts, the uses, and beliefs about them are supplied to the students in the MHA Tribal languages for inclusion in throughout the lessons (See Appendix T).

Lessons Learned

The optimum and purest uses for the framework would be in a biology, ethno botany, ecology, botany, ecology, environmental science or Tribal Studies course. However, some of the activities could be incorporated into other classes or used in a holistic or cross-curricular design. For example, one main activity for many different lessons is a literature review. The students use electronic, print resources, and interviews to learn the taxonomy, botanical characteristics, and historical as well as contemporary uses for the plant being studied. Literature review and lessons on information literacy could be used in any science, composition, history, or research methods class. For purposes of delineating activities into somewhat smaller categories plants and their principle uses have been divided into the categories of structural, edible, and medicinal/spiritual. Instructors should also inform students that many plants had uses across all three categories and they may include these uses in their activities if appropriate. These categories should be some of the first information the instructors share

with the students. An activity involving structural uses of plants in dwellings, weapons, or furnishings could be incorporated a mathematics, physics, or actual construction technology course. Under the topic of edible plants activities could easily be incorporated into a health, home economics, nutrition, horticulture or anatomy and physiology class. There are multiple potential applications of chemistry involving plants ranging from plant nutrients, water quality, soils, to human nutrition classes. The topic of medicinal use of plants could be easily be incorporated into an anatomy and physiology, microbiology or pharmacology class.

Below is an outline of the plant-based framework with suggestions and guidelines for each portion.

Plant-Based Framework

1. **Preparation and Planning**-Unless the instructor is well versed in Traditional Ecological Knowledge (TEK) of the local area and botanical information regarding the local ecosystem the instructor needs to gain commitments from cultural resource people and botanical resource locations and people. The instructor has outlined courses into which plant-based lessons will be incorporated and tentative lengths of time for inclusion. Instructors should obtain required materials ranging from a planting space, seeds, cameras, examples of plant parts, posters, and books. Internet sources and internet searches are also recommended resources for information. Instructors should caution learners to use reliable sources to avoid false information.
2. **Getting Started**-The instructor introduces the topic to students along with an outline of activities, objectives, and expected outcomes. Learners are led through a discovery process to assess what they already know about local plants, ecosystems, and historical and present uses for local traditional plants. Learners become familiar with the local plants with a focus on cultural, historical and present uses. Instructors are urged to stress basic categories of uses (structural, edible, and medicinal). This background information can be provided by the instructor through handouts of readings, videos, or students conducting their own research regarding the topic. This research could be conducted through electronic literature reviews, library searches, interviews, or other means. A visit to a Tribal Museum or Cultural Center could be

incorporated at the beginning of the plant-based curricular unit. An integral part of the discovery process should be guided by a Culture Instructor or Tribal Elder to introduce the local TEK.

3. **Plant Selection-** Either individually or preferably in small groups learners are instructed to select a plant for future study. Instructors should guide learner choice either by category of plant use (structural, edible, medicinal) or have the learners simply select a plant and later determine historical and current uses. As learners' choice of plants will largely determine the resulting activities the instructors may want to limit plant selection based on resources available and time allowed for the lessons.
4. **Review of the Literature-**Learners will research through various means such as, electronic databases, library resources, community sources, Elders, and interviews the uses for their selected plants by the Indigenous people of the area, as well as, the plant's niche in the local ecosystem and the plant's original and current ranges. Learners will present their findings to the instructor and or classmates. Findings should include Native name for the plant, its parts, and uses if possible.
5. **Field Exploration-**The instructor should make every effort to include field activities into a natural ecosystem, a traditional farm, or both. Any visit should be accompanied by a cultural resource person or Elder if possible for inclusion of culturally relevant information. The instructor should also invite a botanical expert along on the field explorations. Information should be stressed regarding a Native view of the natural interrelatedness of ecosystems whether wild or cultivated. The niche of the plant in the local ecosystem and the interactions of producers and consumers and nutrient cycles should be presented as part of the field explorations or maybe addressed later on in the classroom. Lessons could also be included regarding plant species diversity and sustainability depending upon lesson objectives and course selection. The instructor may determine the quantity of material to be presented prior to, during and after the field exploration activities. Instead of sampling the ecosystem visited whether wild or cultivated, learners should be assisted with capturing plant specimens on film as opposed to gathering samples whenever possible.
6. **Activities-**After conducting their review of the literature and field exploration activities, learners should select a product that they wish to complete from their or other classmates plant choices. If learners have focused on a structural use of a plant they should produce actual or model dwellings and furniture, tools, weapons, boats, utensils, etc. as products for structurally related plant uses. Depending upon availability of actual plant material/supplies, the instructor may allow students to substitute readily available renewable

materials to produce products. If learners have selected edible plants the activities involving edible plant choices will depend upon the plant choice and may involve either cultivation or gathering of the plant's produce. Cultivation can range from small indoor germination activities to an entire class planting a garden and harvesting the produce. Activities involving gathered fruits, tubers, vegetables, and syrups will depend upon availability of these resources approved for harvesting. All activities, whether cultivated or gathered, should include teaching from Elders or cultural resource persons and should include Tribal language, beliefs and practices surrounding the plants and their preparation, consumption or preservation.

7. **Assessment of Learning**-Learners should produce a product after completion of their activities. They should present their findings regarding this plant to their classmates, instructor and if possible their community members. Products may include items for display, foods, gardens, pictures, PowerPoints, or other methods chosen by the learners. Products can be assessed by the instructor with assistance from the cultural advisor for depth of understanding into Traditional Ecological Knowledge and botanical information contained in the presentations or products.

Final Thoughts

One of the important outcomes of this plant-based framework is to get the students to become active researchers; researchers that explore their own lives so that they can connect their own lived experience with that of their community members. Ann Egan-Robertson (p. 282, 1998) has stated, "students ethnographic research can be viewed as a kind of "native anthropology"...Rather than exporting knowledge of a community for use by others, ethnographic research becomes a way for people to reflect on their own communities by developing a better understanding of the cultural dynamics in which they live".

The author believes that the use of the plant-based framework has increased his students' interest in the local plant community and its historical/traditional uses and the

current status of the local habitat. This is evidenced by high levels of quality of student products, student self reports, course evaluations, and students' presentations of their scientific posters at national meetings and competitions. The author also plans to improve the quality of his plant-based lessons through more inclusion of native languages and customs, as well as, increased time spent by learners in the natural settings.

The author hopes that educators of American Indian/Alaska Natives and others living both on and off reservations will use all or parts of this plant-based curricular framework in their classrooms. Hopefully, the framework can be used to increase the level of cultural relevancy in their lessons and also improve their learners' level of understanding of and connection to their local ecosystem.

CHAPTER 5. SUMMARY AND CONCLUSIONS

This research has provided information on the cultural, horticultural, and educational connections of the re-establishment of Juneberries on the Fort Berthold Indian Reservation. The Mandan, Hidatsa and Arikara Elders' survey revealed extensive time spent by multiple family members gathering, preparing, and consuming Juneberries when the MHA members resided in the fertile Missouri River bottomlands. The survey also documented the drastic changes in Juneberry appropriation and use common today after the forced relocation from the bottomlands caused by the flooding from the Garrison Dam Reservoir. A nearly unanimous interest in seeing broad re-establishment of Juneberry efforts undertaken on the Fort Berthold Indian Reservation was the summary finding of the survey of MHA Elders.

The horticultural findings of this study reinforced previous research regarding the importance of water availability on transplant attrition rates of selected cultivars. It also provided information regarding the plant health and vigor of several selected cultivars at different sites with different degrees of water availability.

The presentation of a native plant-based curriculum framework was the final product of this research. The framework was presented as one method of increasing the level of cultural relevancy of curriculum presented at a Tribally Controlled Community College.

This research offered new insights into the levels of integration of nature, science, and family in Mandan, Hidatsa, and Arikara culture especially in the past. The picking,

processing, and consuming of Juneberries was a pleasant time for shared family experience that epitomized enjoying nature's bounty while appreciating its goodness for healthy body, mind, and spirit. This research documented the extensive nutritional and lifestyle changes forced upon the members of the MHA Nation after relocation caused by the flood waters of the Reservoir Sakakawea. The research also documented their high level of interest in Juneberry re-establishment among the elders of the MHA Nation. This was evidenced by the strong feelings and pleasant emotions they expressed regarding memories of Juneberry related activities from their youth and young adulthood. They would like to see these traditional practices brought back to be enjoyed today by their descendants.

The interest levels of the young tribal members in learning about their native plants and environment is further evidence of the connection between nature, science, and the Native youth. They are reconnecting with the importance of respecting and understanding the natural world and the native plant based curriculum framework allowed them the opportunity to do just that.

This research may influence other researchers, Native American students and professionals, to use qualitative methodologies to better understand events and practices that have impacted their Indigenous nations here in the North America and world wide. Respectfully obtaining elders and other tribal members accounts of past events, practices, or environmental activities can provide insights and culturally relevant references that can be combined with documentary evidence and other data sources to clarify and or verify historical events or changes on their reservations and reserves.

The results of this research indicated the need for additional study to ensure the successful reestablishment of Juneberries on the Fort Berthold Indian Reservation and elsewhere. Factors deserving further study include soil moisture effects, cultivar yield and performance, investigation into traits of existing native Juneberries, and expanded study into nutritional value of Juneberries.

The framework for a plant based curriculum also provided suggestions for future expansion and alteration of its application. There is a need for better assessment of the impact of a culturally based curriculum has upon student learning. Long term qualitative and quantitative studies are needed to learn more about the impact and importance of culturally relevant materials upon various ages of American Indian students. The plant based curriculum can also be adopted or expanded into other culturally relevant areas including but not limited to place, art, music and dance, and sports.

This study also indicated the need for development of specific activities and events to reintegrate the Juneberries into the educational and social systems of the reservation communities after their successful reestablishment on the Fort Berthold Indian Reservation. Community members, elders, and educators need to develop plans and practices to maximize the impact of large community Juneberry plots for nutritional, cultural, and educational benefits for the community members.

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APPENDIX A: JUNE BERRY INTERVIEW COVER LETTER AND INTERVIEW

QUESTIONS

Dear Elder:

Hello. My name is Kerry Hartman. I have been an instructor at Fort Berthold Community College for over 20 years. I know some of you and I hope many of you know me or have heard of me. I hope most of what you have heard is good!

Please consider answering these interview questions regarding Juneberries. I am doing my doctoral research on Juneberries to learn how to best re-establish them widely throughout the reservation. Therefore, I need to learn some things about Juneberry growing and usages in the past and present. The short interview has two parts. The first part asks you to share what you learned and did in the past regarding gathering and using Juneberries. The second part includes questions that ask about present and future uses.

The information gathered from this brief questionnaire will be totally anonymous and confidential. A summary of the results will be available by contacting me.

Thank you very much for helping me, if you choose to respond to these questions. If you are concerned about your anonymity, I guarantee the anonymity of your responses. Upon completion of the interview, I have a gift for you as a small token of appreciation for your time and assistance on this important interview.

Sincerely,

Kerry Hartman
Science Instructor FBCC

Historical Information:

1. Please share did you ever help gather or use Juneberries when you were young? Yes
No

2. Please briefly describe exact area where Juneberries were usually found (river bank, coulee, side hill, bottom of draw, or others).

3. Please describe what other plants, if any, were generally mixed with or around the Juneberry patches?

4. Please briefly describe what things affected the Juneberry bushes (not the berries yet just the plants) (e.g., deer, heavy winter, droughts, insects, late spring, or late frost).

5. Please briefly describe some things that affected the berries how many and their size, taste, etc... (e.g., dry spring, late frost, late snow, drought, winds during blossoming, or birds, etc.).

Uses:

6. Please briefly describe how your family utilized the Juneberries (fresh, dried, pudding, cornballs, etc.).

Present and Future Uses of Junberries

1. Please report-do you or your family pick Junberries now? Yes or no.

2. If no, why? (Don't need to, don't like to, etc.)

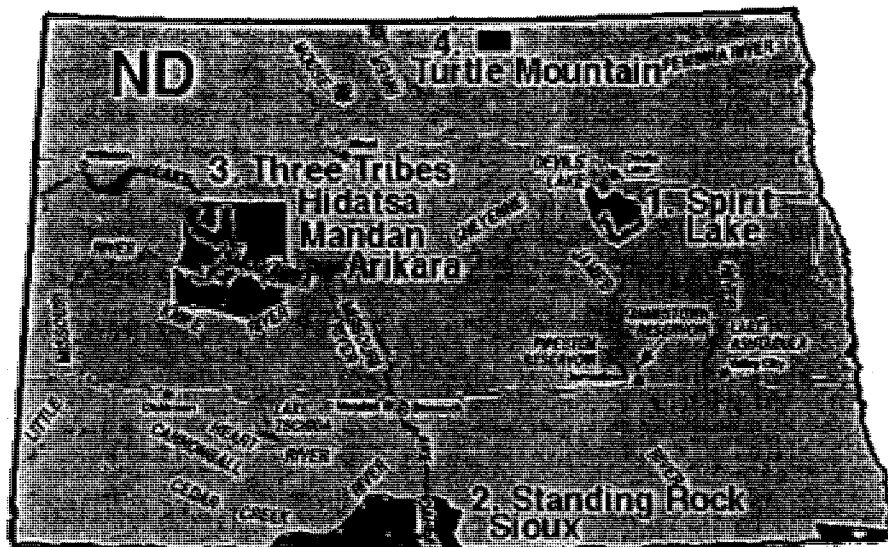
3. If yes, why? (food, habit, tradition, etc.) Also please briefly describe where (without revealing your secret spots☺)

4. Please describe how you use Junberries today (fresh, frozen, dried, cornballs, pudding, etc.)?

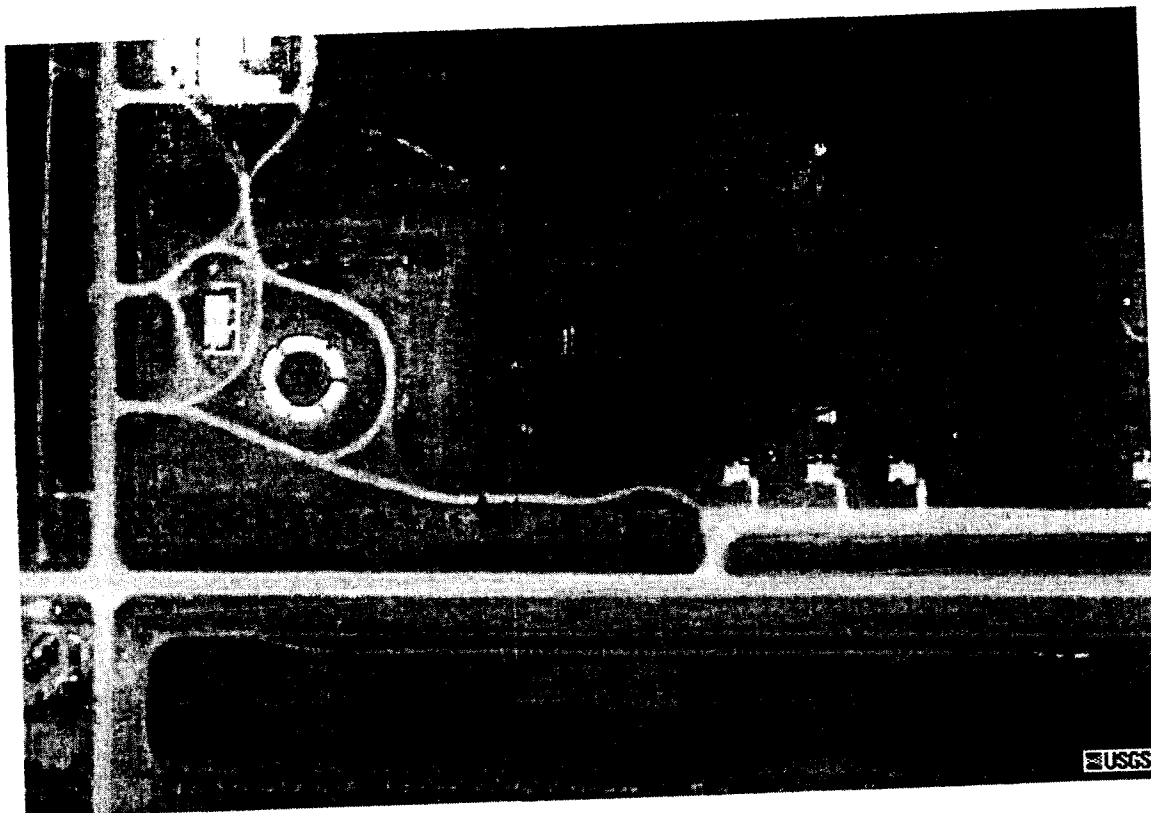
5. Please discuss any differences you have noticed in Junberries now and when you were younger (bush size, berries, location, etc.).

6. Would you like to see Junberries more available here on Fort Berthold Reservation? Yes or no and Why?

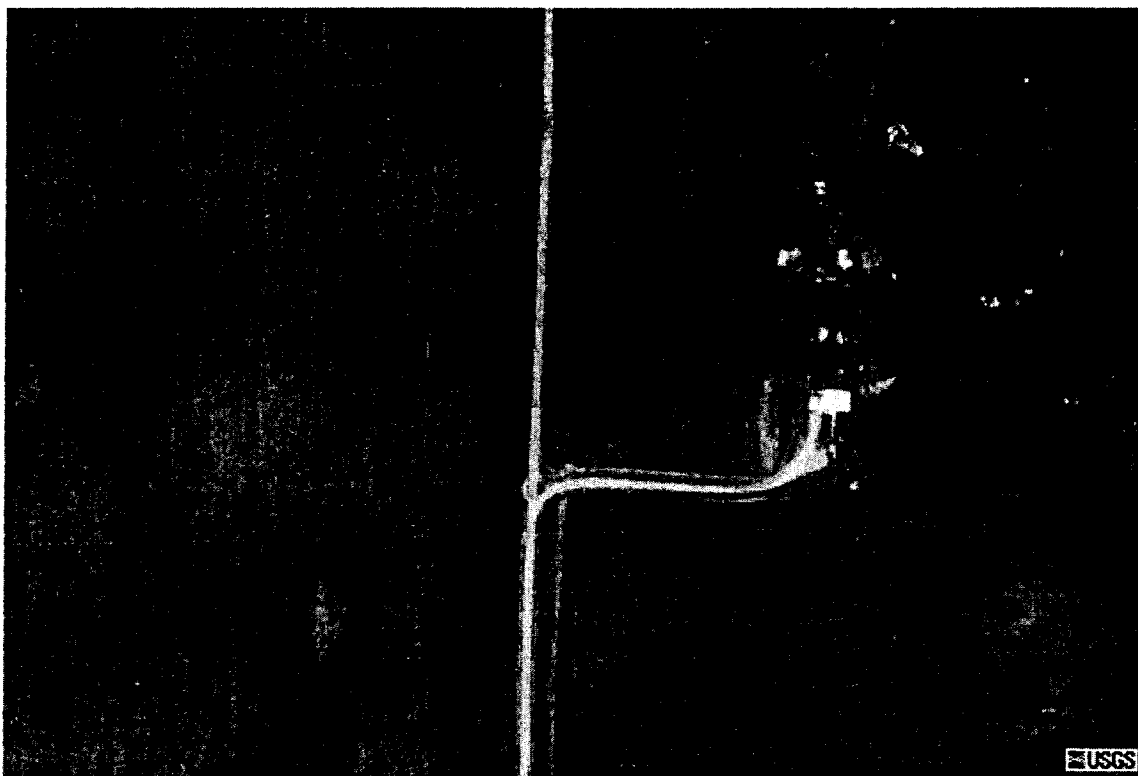
APPENDIX B: STATE OF NORTH DAKOTA WITH RESERVATIONS MAP



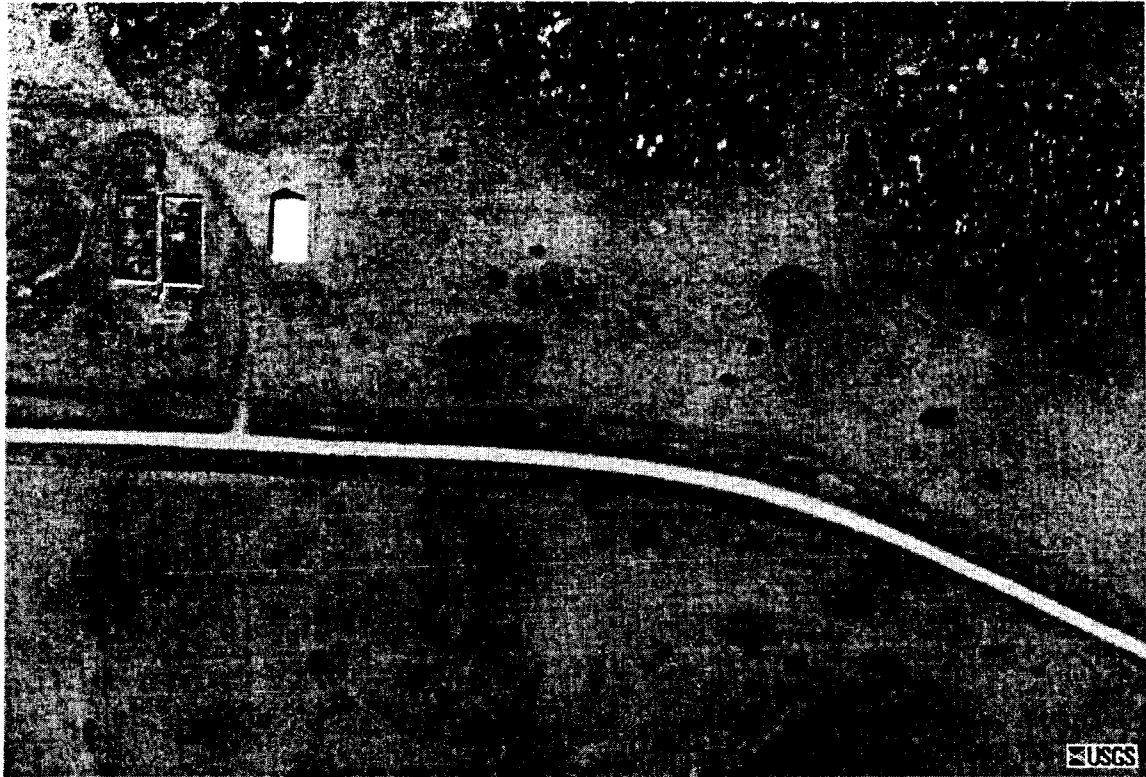
APPENDIX C: WHITE SHIELD JUNE BERRY SITE MAP- 47°38'N 101°50'W



APPENDIX D: WAR COULEE JUNE BERRY SITE MAP- 47°42'N AND 101°50'W



APPENDIX E: MANDAREE JUNE BERRY SITE MAP-47°41'N AND 102°30'W



APPENDIX F: SOIL ANALYSES RESULTS

Soil Texture Classification

Site Identification	Classification
Mandaree NW 2/3	loam
Mandaree SE 4/5	fine sandy loam/sandy clay loam
War Coulee 2 Ap+B	clay loam/loam
War Coulee 3 Top Ap	loam/silt loam
War Coulee 1 B	gravelly clay loam/gravelly loam
White Shield 1 Ap+AB	silt clay
White Shield 2	silty clay loam/clay loam/silt loam

Texture Analysis

Site Identification	Percent Silt	Percent Sand	Percent Clay	Percent Gravel
Mandaree NW 2/3	34.87	44.99	20.13	0.04
Mandaree SE 4/5	24.63	57.32	18.02	0.03
War Coulee 2 Ap+B	45.46	27.15	26.53	0.86
War Coulee 3 Top Ap	48.57	25.96	24.53	0.94
War Coulee 1 B	32.59	39.90	11.72	15.79
White Shield 1 Ap+AB	42.15	12.85	44.21	0.79
White Shield 2	52.79	19.47	27.32	0.42

Soil Organic Matter and Mineral Content

Site Identification:	% Organic Matter	NO₃-N (mg/kg)	Olsen P (mg/kg)	Soil pH 1:1	K (mg/kg)
Mandaree NW 2/3	5.15	4.5	3.0	6.90	396
Mandaree SE 4/5	5.25	4.0	1.5	6.60	274
War Coulee 2 Ap+B	3.90	3.5	2.0	6.15	213
War Coulee 3 Top Ap	2.30	5.0	3.5	7.55	110
War Coulee 1 B	4.20	9.5	20.5	5.75	471
White Shield 1 Ap+AB	3.40	11.5	10.0	5.70	193
White Shield 2	5.80	3.0	3.0	6.90	458

APPENDIX G: ETHNOBOTANY COURSE OBJECTIVES

Biology 106: Ethno-botany

- Department Name: Science
- Course Name: Ethno-botany
- Course Division and Number: Bio 106
- Credit Hours: 4
- Prerequisite: Bio 101 or consent of instructor
- Text: Buffalo Bird Woman's Garden, G. Wilson, Minnesota Historical Society Press. And handouts.
- **Department Goals:**
 - Critical Thinking: Develop students' ability to review topics while using higher-level Critical Thinking Skills.
 - Technology Infusion: Introduce students to a broad range of scientific equipment and technologies and a broad range of research methodologies/
 - Culture Knowledge: Infusion and inclusion of cultural information and/or material relevant to the Three Affiliated Tribes.
- **Course Goals:**
 - To increase students' awareness of past and present uses of plants by members of the Three Affiliated Tribes and other residents of the Northern Great Plains. Emphasis will be on local uses: structural, edible and medicinal.
 - Develop student awareness of general plant systematics, taxonomy, and identification.
- Instructional Materials: Textbook, handouts, reference materials, audio visual aids, plant mounts, videos and computer generated activities
- Instructional methods: Lecture/Discussion, labs, field trips, guest lecturers, and guided field tours.
- **Focused Objectives:**
- **Cultural Objectives:**
 - **Reinforce student awareness of the history of the Three Affiliated Tribes.**
 - **Outcomes:** Students aware of and can define, major historical events including: epidemics; villages/migrations; treaties, laws, federal policies
 - **Measurement:** Students individually or in small groups, successfully construct time line model including: over 25 mile markers of TAT history.
 - **Increase student awareness of the role of horticulture in Three Affiliated Tribes culture; past and present.**

- **Outcomes:** Students aware of size of and design of traditional Hidatsa gardens. Students familiar with planting, care, harvesting, uses, and storage of major vegetables used by the Hidatsa.
- **Measurement:** Students duplicate, model, or describe the planting, care, harvest, uses and storage of the major vegetable crops used by Hidatsas past and present. Students are able to construct and/or draw traditional garden, daily menu, cache pit, drying stage, etc.
- **Increase student awareness of nutritional value of native plants.**
- **Outcomes:** Students are aware of daily traditional and contemporary menu of TAT –100 years ago. Students are aware of contemporary recommended daily dietary guidelines.
- **Measurement:** Students create a daily menu of average TAT family meals from 100 years ago. Students create a daily menu of the contemporary family meal. Students compare and contrast traditional and contemporary TAT meal as evidenced by a chart and a written compare and contrast short paper.
- **Technology**
- **Increase student ability to utilize technology to conduct literature reviews, course assignments and research.**
- **Outcomes:** Students use Internet websites, electronic databases, and electronic libraries to conduct literature reviews regarding traditional plant uses, ethno –pharmacology, plant systematics, and related topics.
- **Measurement:** Students produce bibliography of minimum of four journal articles relevant to topic of choice. Students produce research paper integrating information from literature review on topic of choice.
- **Students utilize botanical, water, and soil quality measurement equipment.**
- **Outcomes:** Students use botanical, water, and soil quality measurement equipment to assess and evaluate field and lab growing conditions.
- **Measurement:** Student produce lab report utilizing data gathered on soil, water and plants to describe growth potentials and conditions. Instructor observation of student use of botanical, water, and soil quality measurement equipment.
- **Critical Thinking**
- **Increase student ability to analyze, synthesize, and evaluate quality of information as presented.**

- **Outcomes:** Students use higher level thinking skills when creating their research topic reports. Students use higher level thinking skills to produce a timeline of major events in Three Affiliated Tribes history.
- **Measurement:** Student creation of term paper discussing information gathered from literature review, synthesized and evaluated from personal viewpoint. Student production of time line of TAT history. It is created in medium of choice with student selected highlights and explanations.

APPENDIX H: NATIVE PLANT ASSIGNMENT

Native Plant Assignment

Course Name/Number _____
Semester/Year _____

Objective: Students will become familiar with plant(s) indigenous to the local ecosystem through literature review, internet searches, interviews, field trips, readings, and other sources.

Activities:

1. Student will evaluate his or her current awareness of native plants.
2. Student will participate on a fieldtrip identifying local native plants.
3. Student will choose one plant to study in depth.
4. Student will conduct literature review, internet searches, interviews and readings to learn more about chosen plant including classification, historical and current range, role in ecosystem, historical and current cultural uses and traditional Mandan, Hidatsa and Arikara names.
5. Student will create a project that showcases his/her knowledge about the plant. Projects may involve structural, edible, or medicinal uses of the plant. Student can bring samples, artifacts, pictures, guest speakers, to be included in the plant presentation.

APPENDIX I: LITERATURE REVIEW DIRECTIONS

Literature Review

- For this assignment, you must use the FBCC library website.
- You will choose one topic find a minimum of 4 articles regarding that topic then read and review each article.

Steps to the Literature Review:

1. To start the literature search, go to the FBCC webpage: www.fbcc.bia.edu.
2. Click on the library link on the left.
3. Click on 'EBSCOhost Research Databases'
4. Check 'Academic Search Premier' and click 'Continue.'
5. On the search page, check the following boxes: 'Full Text' and 'Scholarly (Peer Reviewed) Journals' then type in the topic you would like to search. You may need to narrow your topic if you get too many articles, or broaden it if you get too few.

- Once you find 4+ interesting articles, you can print them off or read them off of the computer screen.
- For your assignment, you must summarize each of the articles in a separate paragraph.
- Make sure to give the article title, author, journal/magazine and date.
- In the fourth paragraph, you should compare and contrast the articles and state what you found interesting, etcetera.

This means that there should be FIVE paragraphs total (one summary paragraph for each article you read and one final compare/contrast paragraph for all three of the articles.

Again, remember to give the article title, author, journal/magazine and date!!!

APPENDIX J: ORAL CULTURE ASSIGNMENT DIRECTIONS

Oral Culture Assignment

-- You must give a 5-10 minute oral presentation in front of the class regarding Native American culture. It can be for any tribe – your own, or another. You may give your oral presentation any time before April 12, however, you will not receive credit if you do not present on or before that date. Here are some ideas:

- Teach the class 10 numbers, words, phrases, colors, etc in a native language. You should have something to hand out to them with the spelling/ phonetics.
- Teach the class about a famous native chief, a certain battle, a tribe in general, a ceremony, etc.
- Teach 10 differences between your culture and another culture (i.e. holidays, traditional food, ceremonies, celebrations, religion...)
- Teach the class a native craft (demonstrate in front of the class)
- Teach the class a native game (we can play it in class – time permitting)

This list could go on forever – be creative and remember to include your source.

APPENDIX K: COMMUNITY INVOLVEMENT ASSIGNMENT DIRECTIONS

Community Involvement Assignment

-- You must complete some sort of community involvement for this assignment. It must be completed this semester and you must write a one page summary explaining your experiences, what you learned, what you liked/disliked etc. You can choose from one of these or come up with your own. However, you must okay it with the instructor. This must be some sort of community involvement, not just a one page paper on an earth lodge or on a tribe.

Attend a tribal council meeting.

Visit the Three Tribes Museum (or another Native museum).

Visit with an elder in the community (one whom you would not normally visit with) for at least 30 minutes. Discuss the importance of culture.

Visit with a child in the community and discuss with them the importance of their culture (i.e. you can ask them what they think is culture and why it is important and then tell them what you think).

Volunteer 2 hours of community service on the reservation.

Attend a Native American seminar.

Interview a prominent tribal member.

** There are many other ideas that you can use for these two assignments – if you would like to do something other than on this list – just okay it with me beforehand (via email or in person).

APPENDIX L: SCIENCE TEAM PAPER OR POWERPOINT PRESENTATION

DIRECTIONS

Science – Term Paper or Power Point Presentation**Term Paper:**

- Text should be four pages in length: 12 point font, double spaced, 1” margins (this does not include the title page and references).
- You can choose any topic covered in your class textbook.
- If you chose to write the term paper, you must use documentation. That means that after each sentence that is not your own original thought, give credit to the reference like this. (Calfee, 27) This denotes the author and page where this statement came from. It seems redundant, but you must do this after every single sentence unless the knowledge came directly from your head.
- *Make sure you re-word text into **your own words** – if you want to quote directly use “quotation marks.”* (Then use the documentation as above.)

Power Point:

- Presentation should be about 10 minutes long with at least 15-20 slides.
- Slides should have large font and only *summarize* what you will be speaking about.
- You should not read directly from the slide – this makes for a poor presentation. You should also have visuals/pictures on your slides to make it appealing for the audience.

Both:

- Include a title page with: title of paper, your name, date, Geology 110, Fort Berthold Community College (or your college).
- You must use at least **FOUR REFERENCES!** Of these, you can use books, online references and journals/magazines.
- You should have a page/slide with an alphabetized list of your references. Use the following formats:

An online journal article

Kenneth, I. A. (2000). A Buddhist response to the nature of human rights. *Journal of Buddhist Ethics*, 8(4). Retrieved February 20, 2001, from: <http://www.cac.psu.edu/jbe/twocont.html>

Magazine article

Henry, W. A., III . (1990, April 9). Making the grade in today's schools. *Time*, 135, 28-31.

Book

Calfee, R. C., & Valencia, R. R. (1991). APA guide to preparing manuscripts for journal publication. Washington, DC: American Psychological Association.

The FBCC online library (<http://lib.fbcc.bia.edu/FortBerthold/default.asp>) has lots of online references: If you are not on the FBCC campus when you are accessing this, you will have to use this code: 23125001133063 and password: bertlib.

Once again, do not plagiarize – use your own words to sum up what other authors have written.

If you have any questions about this, please ask me!

APPENDIX M: NATURAL PRODUCTS WORKSHOP OUTLINE

Natural Products Workshop 2007**Fort Berthold Community College, New Town, ND & Northern Plains****Undergraduate Research Center (NPURC)****July 2-6, 2007**

An Introduction to Research Workshop investigating the chemistry of natural products will be conducted at Fort Berthold Community College in New Town, ND from July 2-6. The workshop will be presented by Dr. Fathi Halaweish, Dr. Andrew Sykes and Kerry Hartman, experts in the field of plant chemistry. Students will also be provided with a \$500 stipend for participation in the workshop. Housing for out-of-state participants will also be provided (Sunday thru Thursday) in New Town, ND or nearby. Both introductory lectures and intensive hands-on laboratory activities are included in the workshop. Abstracts of the proposed research activity are provided below. Interested students should submit the following application to Kerry Hartman at FBCC.

Exploring Drug Candidates and Antioxidant Properties of Native Plants

Dr. Fathi Halaweish, SDSU and Dr. Andrew Sykes, USD

Plants have formed the basis for treatment of diseases in traditional medicine for thousands of years and continue to play a major role in the primary health care of about 80% of the world's inhabitants (World Health Organization statistics). It is also worth noting, that (a) 35% of drugs contain 'principles' (key structure elements) of natural origin; (b) less than 5% of the 500,000 higher plant species have undergone biological pharmacological screening. Each plant has potentially 10,000 different constituents. The discovery and development of efficacious therapeutic agents from natural sources provided convincing evidence that plants could be a source of novel medicinal drugs. Western medicine uses many drugs extracted from natural products (NP): aspirin, atropine, cocaine, curare, digitalis, ephedrine, hyoscine (scopolamine), opiates (codeine, morphine), pilocarpine, primrose oil, quinine, reserpine, steroids, taxol, warfarin, menthol, etc. While the natural product isolated as the active compound might not always be suitable for development as an effective drug, it can provide a suitable lead for conversion into a clinically useful agent. This part of the workshop aims to unveil the potential of drug candidates from plants in our own communities. Several plant sources will be selected and processed according to standard biological screening protocols. The Vitamin C content and antioxidant properties of native fruits will also be explored.

Experiments: Students will be prepared to conduct the following experiments:

1. Conduct analytical extraction using ultrasonic extraction, purification and estimation of total phenolic contents.

2. Conduct bioassay-guided separation of biologically active compounds(s)
3. Accomplish screening for biological activities such as antioxidant (using free radical scavenging assays), and test for cytotoxicity/anticancer.

Steam Distillation and Preparation of Fragrant Vapors

Dr. Kerry Hartman, FBCC

Both white cedar and wild mint were used in the past by American Indians. White cedar was used as a fragrant vapor for spiritual cleansing in sweat lodges. The cedar twigs were simply boiled in water to release the fragrance of the oils in the plant tissue. Wild mint leaves were used to make tea, reduce fever, soothe sore throats, and also as a vapor in sweat lodges. In the French-Cree language wild mint leaves are called “Laboom”, and in the Chippewa language they are called “Wiinisiibaug”.

Schedule:

Day 1	Dr. Fathi Halaweish, SDSU
July 2	9:00-4:30 Introduction to Phytopharmaceutical and Nutraceutical Preparation Laboratory techniques in discovery of biological activity
Day 2	9:00-4:30 Continue laboratory techniques in discovery of
July 3	biological activity
Day 3	Dr. Andrew Sykes, USD
July 4	9:00-4:30 Using spectroscopy, the Vitamin C and antioxidant content of native fruits such as Currants and June Berries will be explored.
Day 4	Kerry Hartman, FBCC
July 5	9:00-4:30 Steam Distillation of White Cedar and/or Wild Mint
Day 5	9:00-4:30 (If time allows) Preparation of Linalyl Acetate (Sage
July 6	Odor)

APPENDIX N: JUNE BERRY PHOTOS



Photo 1: Measuring Juneberries



Photo 2: Juneberry Planting Fall 2008

APPENDIX O: FIELD TRIP PHOTOS



Photo 2: Cross Ranch Ethno-Botany Field Trip



Photo 3: Cross Ranch Trip-College for Kids

APPENDIX P: STUDENT PROJECTS

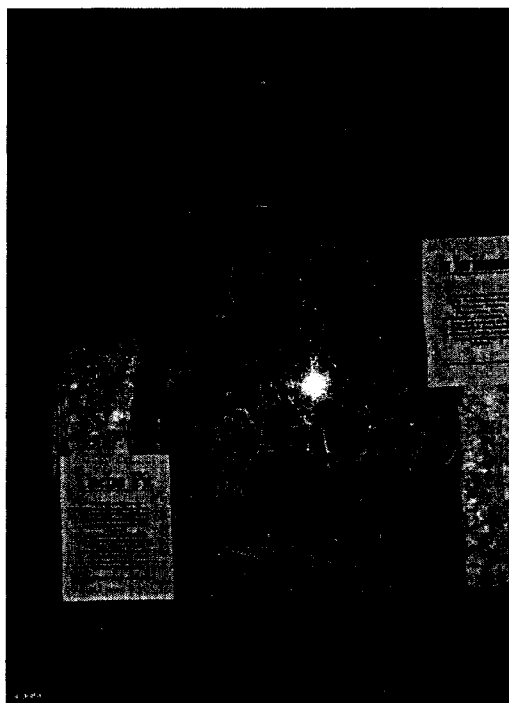


Photo 4: Hidatsa Cache Pit

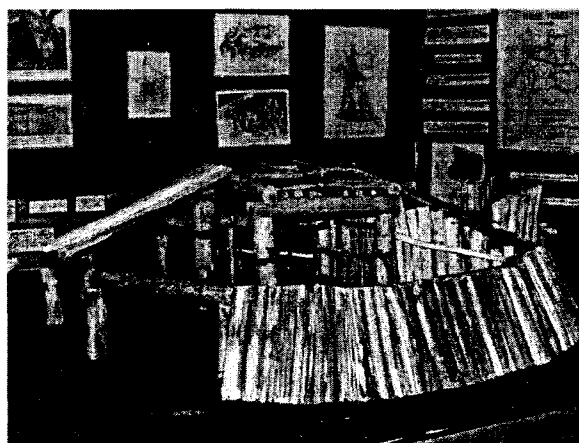


Photo 5: Earth Lodge Model

APPENDIX Q: STUDENT POWERPOINTS

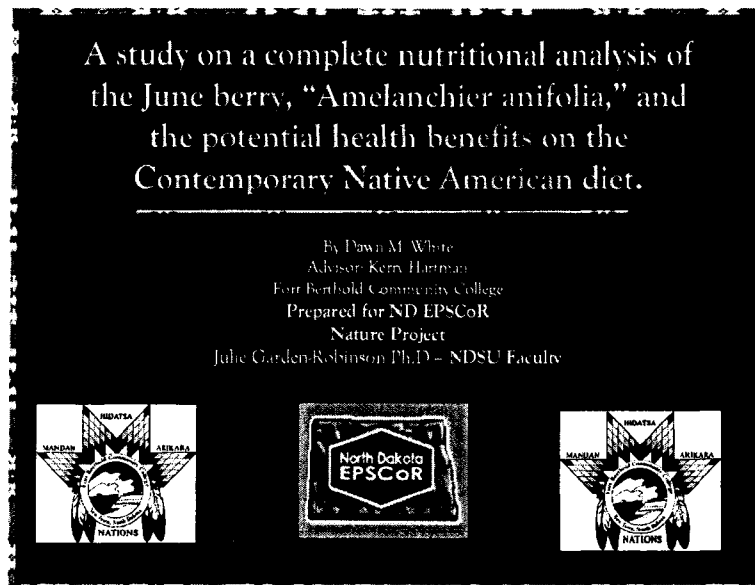


Photo 6: Sample of Student Research PowerPoint

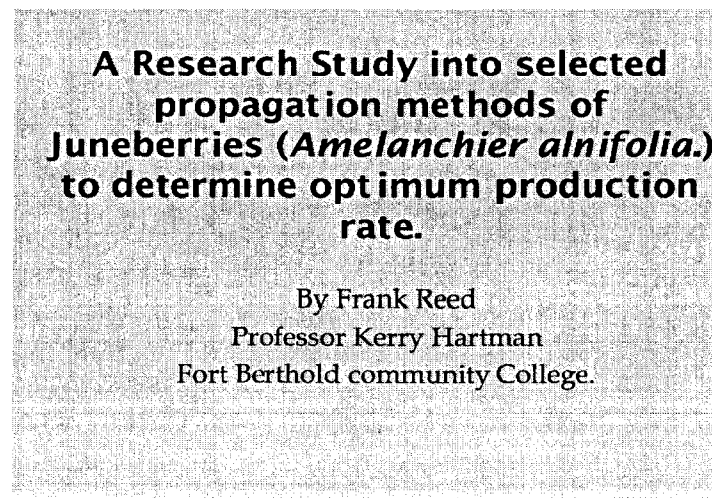


Photo 7: Sample of Student Research PowerPoint

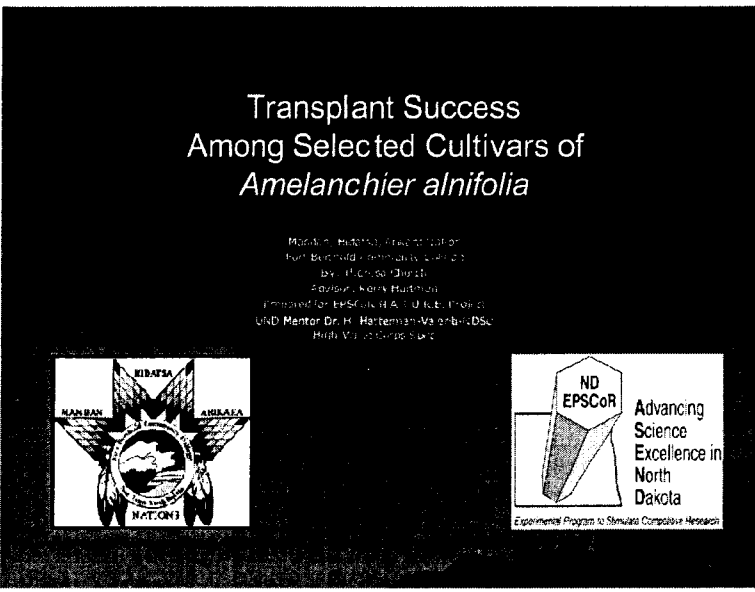


Photo 8: Student Research PowerPoint

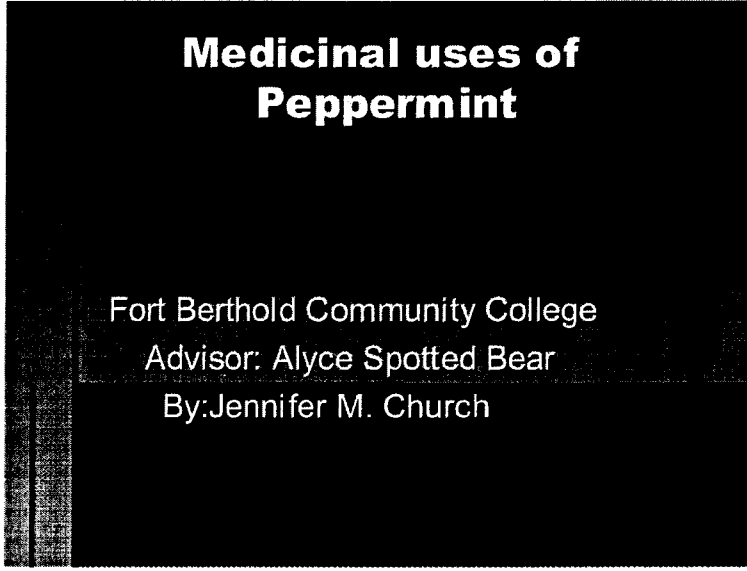


Photo 9: Student Research PowerPoint

APPENDIX R: STUDENT TIMELINE

Three Affiliated Tribes Time Line History

disfor
small pox
[REDACTED]
[REDACTED]
[REDACTED]
acts/congress

1300-FIRST BAND OF HIDATSA (AWADIXA) ARRIVED FROM THE NORTHEAST AND SETTLED NEAR MANDAN, ND

1600-SECOND BAND OF HIDATSA-(ORMA-XAWI)

1605-THIRD BAND, HIDATSA PEOPLE ARRIVE FROM DEVILS LAKE AREA-JOIN THE MANDAN

1738-VERENDRYE-FRENCH EXPLORER VISITED MANDANS

1781-FIRST MAJOR SMALL POX EPIDEMIC REDUCED MANDAN FROM 13 TO 9 VILLAGES IN THE HEART RIVER AREA & TO 2 VILLAGES BUILT NEAR THE THREE HIDATSA VILLAGES NEAR THE KNIFE RIVER.

1797-98-TRIBAL COUNCIL CREATED TO PROTECT THE PEOPLE.

1804-05-LEWIS AND CLARK-CORPS OF DISCOVERY SPEND THE WINTER WITH THE MANDAN AND HIDATSA AT KNIFE RIVER

1837-SECOND MAJOR SMALL POX EPIDEMIC AT KNIFE RIVER VILLAGES.

1839-BUFFALO BIRD WOMAN BORN

1845-MOVED TO LIKE-A-FISH-HOOK VILLAGES

1849-WOLF CHIEF BORN (HER BROTHER)

1851-FT.LARAMIE TREATY-

1855-BUFFALO BIRD WOMAN MARRIED MAGPIE

1862-ARIKARA JOINED MANDAN AND HIDATSA

1865 RESERVATION ERA

1867-MAGPIE DIED

1868-MARRIED SON OF STAR

1869-(SON) GOOD BIRD BORN

1876-CONGREGATIONAL CHURCH ARRIVES AT FT. BERTHOLD AND OPENS A MISSION SCHOOL.

1877-DR. WASHINGTON MATHEWS FIRST DR. ON FT. BERTHOLD

1878-13 CHILDREN ARE SENT TO FIRST BOARDING SCHOOL-HAMPTON INSTITUTE IN VA.

**HOOK VILLAGE, START OF DISTRICTS
ELBOWOODS, CHARGING EAGLE, RED BUTTE, INDEPENDENCE AND NISHU**

[REDACTED]

**1894-ALLOTMENTS-160 ACRES PER FAMILY, 949 ALLOTMENTS GIVEN OUT.
1906-18-GILBERT WILSON, WRITER ANTHROPOLOGIST, VISIT BUFFALO BIRD
WOMAN 2MONTH EACH YEAR.**

**1910-CONGRESS 360,000 ACRES TO HOMESTEADING TO NON-INDIANS IN
NORTHEAST AREA OF RESERVATION**

1924-INDIANS GRANTED US CITIZENSHIP

1931-FIRST STUDY OF DAMN

**1934-INDIAN RE-ORGANIZATION ACT PASSED. THREE TRIBES ADOPTED
CONSTITUTION**

1944-FLOOD CONTROL ACT OF 1944 PASSED BY CONGRESS

[REDACTED]

By: Reverta Drags Wolf

APPENDIX S: MANDAN, HIDATSA, ARIKARA PLANT WORDS

Arikara Word	English Word
naca nahnu	Juneberry
huu'	pudding
hakuxk	put or place in water
hoowisaháhnini'	along the bank (above the water)
kanihaahčipana'u	water the garden
nuhuukaáta [NAhuukaátA]	By The Water Bundle (one of the Ree Villages)
hunaanaruhno	work soil (for or before planting)
kanihaánu'	garden, field (of something grown) (where things are planted)
raanakara'u	plant a garden
taát'u	stem of a plant
wahuxčipiriinu'	fresh squash when it first comes on a plant
skanúsu'	animal paunch, used for carrying water
tskatawa'a	consume water
tstaar	to be full of water
tstoóxu'	water
wahuxanaáxu'	watermelon
cirahkataraawih	pour a large quantity of water on something
činihnaáku'	Ash tree
tawá	to be on a tree (references fruit) bear fruit
wanahkúsu'	name of the group of songs sung by doctors as they went around the Cedar Tree and Stone
waraačee	thick brush, thick trees, thick timber
načísu'	any evergreen tree
taapeerik	stand upright, set upright (tree)
naaisaáku'	Bullberry tree or bush
nakaanustaátu'	Chokecherry bush or tree
haahtekux	to be a forest, be a large body of trees
haak	to be a tree
haapiina	bend a tree in order to reach fruit
tara'u	pick (vegetables, fruit, berries)
kasara'uk	pickoff, as berries of fruit
raasštawiš	as of meat or crops; be abundant, as berries on a bush
reehaas	be mature, ripe, ready to pick
aahkasara'uk	pick one's teeth

Juneberry-Mandan	Juneberry-Hidatsa
Mawna Boosh-a-geh	Ma-dsu-da-ba

APPENDIX T: NATURE PARK FLYER

You are invited to attend a brief ceremony in dedication of the Culture Center Nature Park.

Today at 2:00 on the Culture Center grounds.

Mr. Delvin Driver will be blessing the grounds and trees and saying a prayer.

There will be cake and punch afterwards.

This is also a ceremony acknowledging and thanking the Ecological Society of America's SEEDS Program and the Natural Resources Education Grant for the many programs that they brought to the college. These include: Ruth Short Bull (and all that she did), the re-establishment of Juneberries, Sunday Academy, testing TAT's bison for selenium (an element that fights cancer), tracking the black-tailed prairie dogs, surveying Fort Berthold's trees, Honor the Elder's Trees Project, allowing students to attend different science conferences, paying student interns and too many, many, many more to list.

Please attend, help celebrate the trees and new park and have some cake!

APPENDIX U: GERMINATION ACTIVITY

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Planting

Once you've decided what to plant, how much of each crop to plant, and when to plant each one, you and the children will be ready to dive in. It's handy to set aside an area of the classroom for potting and planting, ideally close to a water source. In some classrooms, children cover their desks with newspaper or large plastic bags and prepare pots and plant seeds there.

When planting time comes, you'll either plant directly into permanent containers, or you'll plant thickly into containers from which you will transplant seedlings later.

Sowing Into Permanent Pots

You and your students will start some seeds in their permanent pots, either because they are crops that do not transplant well (see list below) or because you choose not to take the extra time to transplant with the class.

There are a number of plants whose tender root systems are shocked or damaged from transplanting. Although the classroom garden environment is more forgiving than the outdoors, and there is less chance of seedlings being set back by transplanting, the following crops should always be sown directly into their permanent containers:

beans	squash
peas	carrots
cucumbers	beets
melons	radishes

Sowing For Later Transplanting

You may want to sow seeds into temporary pots and transplant them later for a number of reasons:

Transplanting is an important and exciting gardening practice. Tiny seeds are hard to handle and place where you want them. Scattering small seeds (like those of petunia and impatiens) and transplanting them later makes sense.

Transplanting can also be a space-saving activity. For instance, if your indoor garden is full and you want to start some seeds to take the place of maturing plants, sow them thickly in a shallow container and give them a head start. When you transplant them, you can choose only the healthiest ones so weaker plants won't take up space under the lights. If you want to start many cuttings and seeds for a plant sale or for children to take home, save space, and choose the nicest plants, by planting thickly and transplanting later.

Some plants actually benefit from transplanting. These include tomatoes, lettuce, peppers, and onions. Since a tomato plant develops small roots along its stem where the stem touches soil, transplanting it so its stem is deep in the soil increases root development. This, in turn, increases nutrient uptake and anchorage.



Certain seeds that are susceptible to fungus problems (beans, cucumbers, melons, corn) are often treated with a fungicide and dyed (usually pink) for identification. The fungicide is toxic, but it may make the seeds look appealing to kids. Store seeds carefully, warn children of the danger, and wash hands thoroughly after handling treated seeds.

How to Plant Your Indoor Garden

1. **Gather your planting materials.**
 water source
 non-porous container (plastic bucket or plastic bag within a wastebasket for mixing the soilless mix)
 planting containers
 clean soilless or other potting mix*
 seed packets
 potting labels (either wooden popsicle sticks or plastic markers)
 waterproof marker or pencil
 watering bulb, watering can with sprinkling head, squeeze bottle, or plant mister

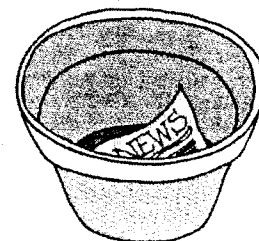
*It's best not to reuse potting mix once you have already grown plants in it. In the warm, moist environment of the indoor garden, used potting mix may pass on disease or pest problems. You can reuse potting mix in compost piles or to repot houseplants or other well-established plants, which are less susceptible to pests and disease.

2. **Measure the amount of soilless mix that you'll need.** Use one of your 6-inch pots as a measure and put the mix into your mixing container. Throw in a little extra so you don't run short.
3. **Pour in about a third as much warm water as you have soilless mix.** (The mixture is very absorbent and is much easier to work with when premoistened.) Continue adding water, mixing with your hands until the mixture is evenly moist throughout. Squeeze some in your hand. If water squeezes out, the mix is too wet. When properly moistened, the mix will form a ball in your hand and crumble when touched. If it's too wet, either add more mix, or leave the containers uncovered to let water evaporate.
 If you have the time, wet the mix and leave it overnight in a closed container to allow more complete absorption of water. If you can't use the moistened mix the next day, keep it covered so it doesn't dry. Don't use mix that has been moistened for more than a week, since it may begin to develop harmful fungus.
4. **If you are using pots that have very large drainage holes in the bottoms,** line just the bottom of each container with a single thickness of newspaper, newsprint, or paper towel. This will prevent the potting mix from falling out through the drainage holes. Don't use shiny newspaper or magazines, as some of the coatings used on these are toxic. Don't leave the paper sticking up above the soil in the pot, as this "wicks" moisture away from the soil and plants.
5. **Fill the container with moistened mix.** Press the mix down lightly with your hand or another container and leave at least 1 inch of headroom at the top. This space will make watering easier later on, and will allow you to add mix later, to help bury root crops and stabilize stems.
6. **Sow the seeds.**
 If seeds are extremely fine, sprinkle them on the soil surface

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Note: 

If you're using slow-release fertilizer (see page 49), the best time to add it is when you are mixing the water and potting mix. This will distribute the fertilizer evenly.



Germination Secrets

Seeds have particular requirements that must be met if they are to successfully germinate (sprout). The two that will most concern you are warmth and moisture.

Moisture

Keep seeds in your indoor garden constantly moist until they germinate. Cover the container with clear plastic or wax paper while the seeds are germinating. This will maintain warmth and moisture, and will allow the children to watch what is happening. Again, don't let the covering touch the soil. If the soil mix seems to be drying out, water with a plant mister or very gentle watering head to avoid washing seeds away.

Check containers daily. Remove the covering as soon as seedlings sprout and set the containers under lights. Begin to water seedlings as described on page 47.

Warmth

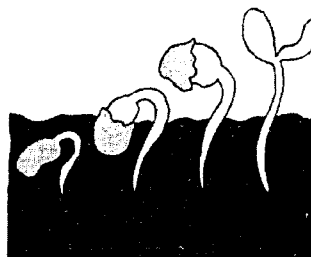
A Grow Lab, warm windowsill, or spot near a heating source will provide adequate warmth for the germination of most indoor garden plants. You won't need to carefully monitor germination temperatures for different plants although seeds do germinate at different minimum, optimum, and maximum temperatures.

If you have a classroom where temperatures fall below 50 degrees for extended periods of time over weekends or vacations, consider using a heating cable (see Appendix D) or a propagating mat (available at many garden centers or through supply catalogs) in the base of your garden. These will provide adequate temperatures for germination.

Table 5 lists the range of germination temperatures for a selection of common indoor garden vegetables. This table will help your students predict when their seeds will germinate. You can use this information to have students place "bets" and turn their predictions into a game.

	Minimum	Ideal Range	Maximum
Beans	60 degrees	70-85 degrees	95 degrees
Beets	40	65-75	95
Carrots	40	60-70	95
Cucumbers	60	70-80	105
Lettuce	35	45-65	85
Peppers	60	70-75	95
Tomatoes	50	70-75	95

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Never place containers directly on top of fluorescent lights, radiators, or other heating or electrical devices.

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Table 6 illustrates the effect of soil temperature on the rate of seed germination, using carrots as an example. With a soil thermometer purchased at a garden supply store, or through one of the suppliers listed in Appendix E, the class can conduct experiments to test the effect of temperature on the germination of other crops, too.

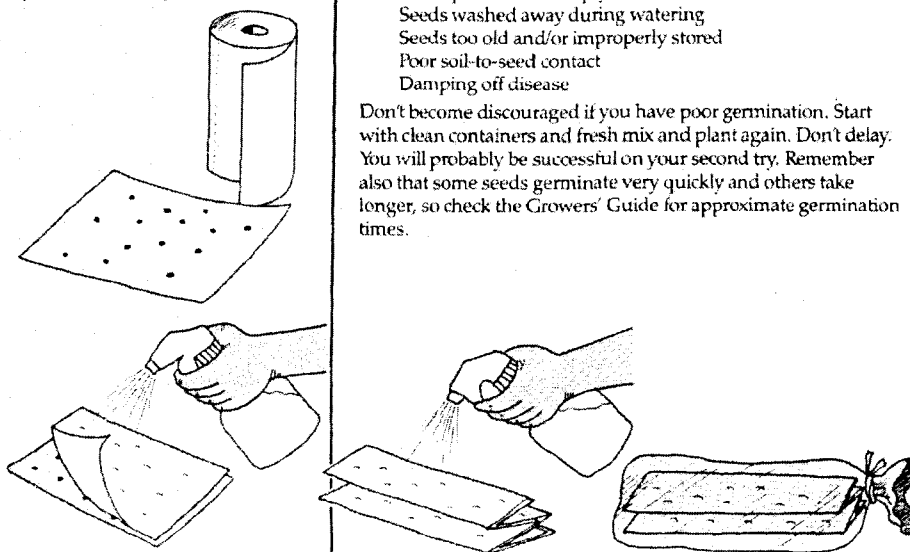
Temperature - Degrees Fahrenheit	Days to Germination
95	8.6
77	6.2
68	6.9
50	17.3
41	50.6



Germination Tests

To see if old seeds are worth replanting, conduct germination tests with your class. For each type of seed being tested, lay out ten seeds on a moist paper towel. Fold up the moist towel like an accordion, moisten again, and place it in a plastic bag.

After a week or ten days, unroll each towel and have children count the number of seeds, out of ten, that have germinated. Then calculate a percentage of germination. If less than 50 percent have germinated, use fresh seed or sow seed more heavily, to compensate for the low germination rate.



Light

Most of your seeds will sprout with or without light. Children should carefully observe containers, however, since they'll need to place the seedlings under lights as soon as they emerge from the soil.

Germination Failure

There are a number of reasons why seeds may fail to germinate. If you have a problem with germination, refer to this list:

- Soil temperature too low or too high
- Soil dried out
- Seeds planted too deeply
- Seeds washed away during watering
- Seeds too old and/or improperly stored
- Poor soil-to-seed contact
- Damping off disease

Don't become discouraged if you have poor germination. Start with clean containers and fresh mix and plant again. Don't delay. You will probably be successful on your second try. Remember also that some seeds germinate very quickly and others take longer, so check the Growers' Guide for approximate germination times.