

INDIGENOUS AGRICULTURE KNOWLEDGE: BARRIERS, INTEGRATION,
POLICY, AND OUTREACH

by

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ABSTRACT

In the Fiscal Year of 2017, out of the 49,140 United States Department of Agriculture (USDA) Natural Resource Conservation Service's (NRCS) cost-share contracts awarded, nationally only 1035 were awarded in Indian Country. This suggests that there are opportunities for NRCS to implement conservation practices on 99 million acres of American Indian lands. The goal of this dissertation is to call for the expansion of NRCS programs on American Indian lands by identifying barriers to American Indian participation in NRCS cost-share programs. The dissertation recommends policy changes to increase participation. This dissertation consists of three chapters and a museum exhibit. The first chapter identifies four barriers to American Indian participation in NRCS cost-share programs: land tenure insecurity, lack of capital, lack of communication, and institutional mismatches. The second chapter describes how management based on Indigenous Agricultural Knowledge (IAK) leads to the same conservation outcomes as NRCS standard practices, but getting IAK based conservation methods approved by NRCS is a complicated process that happens on a case-by-case basis. The third chapter outlines a proposal for Indigenous Field Office Technical Guides (IFOTG) that articulates well with existing instruments, such as Alternative Funding Arrangements (AFA), to increase American Indian participation in NRCS cost-share programs. The IFOTGs will help bridge the gap between Indigenous "Ways of Knowing" and Western science. The goal of the museum exhibit is to demonstrate the continuity and resiliency of IAK practices and provides an example for how Indigenous agricultural methods may be shared with the public by using the Hopi agriculture system as an example. This research employs key informant interviews, case studies, and literature

reviews. Creating better access to USDA conservation programs for American Indian farmers, ranchers, and IAK holders will not only be beneficial for American Indians, but will also help NRCS meet its mission statement of *Helping People Help The Land*.

INTRODUCTION

Expansion of United States Department of Agriculture (USDA), Natural Resource Conservation Services (NRCS), Environmental Quality Incentives (EQIP), and Conservation Stewardship programs (CSP) would help American Indian farmers address environmental and conservation challenges. The purpose of this dissertation is to call for the expansion of NRCS programs on American Indian lands by identifying barriers to American Indian participation in NRCS cost-share programs and recommend policy changes to increase participation. My central hypothesis is that tensions exist between Indigenous “Ways of Knowing” and NRCS institutional management structures which impede federal conservation efforts vital on the Hopi reservation and other Indigenous territories. My research identifies barriers to participation and proposes a policy instrument to create more access to federal conservation programs. The specific aims of this dissertation are: 1) assess the barriers for Indigenous people that prevent them from having full access to Payment for Ecosystem Service (PES) programs (e.g. EQIP and CSP), 2) demonstrate that Indigenous knowledge of agricultural conservation techniques are more suited to their environment and achieve similar conservation outcomes as NRCS standard practices, 3) propose policy solutions for the barriers identified through research by creating a better understanding of the value of Indigenous conservation practices and management schemes, and 4) to illustrate the importance of Indigenous agriculture using the Hopi agriculture system as a model.

Throughout this work where tribal affiliation is not specified, I employ “American Indian” and “Indigenous” interchangeably. For example, I use “American Indian” in my third chapter predominately, because the paper is written for NRCS officials. NRCS is an

entity of a federal agency and the U.S. government uses the term “American Indian” when it refers to federally recognized tribes and its inhabitants and “Indian Country” when referring to reservation lands (18 U.S.C § 1151). The word, “Indigenous” is a common term used throughout the globe to describe a people and its culture who have a historical relationship with their location prior to pre-colonial contact (Berkes, 2012).

This dissertation uses a qualitative methods approach, key informant interviews, case studies, and literature reviews (Auerbach and Silverstein, 2003; Bernard, 2006; Flick, 1998; Ridley, 2012; Yin, 2018). The Hopi best-management practices in the area of agriculture conservation are based on my own personal knowledge and “Ways of Knowing” as recorded in my Hopi agricultural journal covering the years 2005-2017, and as taught to me by my grandfather, Fred Aptvi Johnson (Kimmerer, 2013). A policy approach and recommendations included in my third chapter: *The expansion of Natural Resource Conservation Service cost-share programs on American Indian reservations*, were derived from my findings that were synthesized from my previous two chapters: a) *Barriers to PES programs in Indigenous communities: A lesson in land tenure insecurity from the Hopi Indian reservation* and b) *Examining compatibility and conflicts in the integration of Indigenous Agricultural Knowledge into Natural Resource Conservation Service cost-share initiatives*.

I found that land tenure insecurity, lack of capital, lack of communication, and institutional mismatches, such as limited federal recognition of Indigenous agriculture methods are barriers, which hinder access to federal conservation programs (Johnson et al., 2018). IAK is defined in this dissertation as, “applied knowledge for raising or producing food and other agricultural products grounded in Indigenous belief systems

and practices that have been time-tested over millennia.” As a result of the barriers to NRCS cost-share programs, I am recommending the development of regionally based Indigenous Field Office Technical Guides (IFOTG). The main difference between the IFOTG and NRCS FOTG is conservation practice criteria will be determined through an Indigenous community-based decision making process in consultation with USDA officials. To help support the idea of IFOTGs and IAK based methods, I developed an illustrated photographic exhibit. The exhibit stresses the important aspects of preserving IAK using the Hopi agriculture system as an example.

Expansion of Indigenous agriculture can also contribute to help curve negative health issues found on American Indian reservations, such as heart disease, diabetes, and cancer, because of the traditional foods produced and the labor intensive methods often involved (Belcourt, 2018; Calloway, Giauque, & Costa, 1974). Over time, the expansion of Indigenous agriculture has the possibility of scaling up food production on Indian lands while still retaining the cost-effectiveness and environmental benefits that have been found to be lacking in conventional agriculture (GAO, 2017). The scaling up of food production will assist with issues related to food security by making more nutritional products available in reservation-based communities (Walker et al., 2010). The expansion of Indigenous agriculture will also assist in reinforcing tribal culture, identity, and “Ways of Knowing, “ which have enabled Indigenous people to survive since time immemorial.

My future research will continue to address the issues associated with the barriers in the area of conservation management on Indigenous lands. Results demonstrate how a policy instrument like the IFOTG can help overcome the barriers to participation and

promote the expansion of American Indian agriculture. Conservation models based on Hopi “Ways of Knowing” and other Indigenous conservation agricultural management schemes may further help scientists, NGO’s and federal entities offer new solutions concerning environmental degradation, cost-effectiveness, and human well-being.

PRESENT STUDY

The present study incorporates three individual papers (Appendix A-C) and an exhibit essay (Appendix D). The following sections will be arranged by research aim and provide a small summary of the purpose, methods where applicable, findings, and relevance to my main research goals. My part in the writing of the papers and the putting together of the exhibit will also be mentioned. The papers will also be discussed in the order they will appear in the appendix.

AIM 1: Determine the barriers associated with PES programs, such as EQIP for not only Indigenous people in the United States, but also in under-represented Indigenous populations in under-developed countries.

To address this aim, I led a paper to look at the barriers associated with administering a Paid for Ecosystem Service (PES) program on Indigenous territories using the Hopi Tribe as a case study (Appendix B). The PES program used was an NRCS cost-share program called the Environmental Quality Incentives Program (EQIP).

Paper Title: Barriers to PES programs in Indigenous communities: A lesson in land tenure insecurity from the Hopi Indian reservation (Johnson et. al 2018)

This paper examines the barriers associated with Paid for Ecosystem Service (PES) programs for Indigenous participants using the Hopi Tribe as a case study. An inductive coding method was used to flush out thematic barriers from primary documents and key informant interviews. The results showed that land tenure insecurity, lack of capital, lack of communication and institutional design flaws were common not only in developed countries but also undeveloped countries. A literature review was also conducted using the terms “paid for ecosystem services” and “Indigenous people” in the

journal of *Ecosystem Services*. The literature review showed that only 2 articles were written about PES programs and Indigenous communities in the Organization for Economic Cooperation and Development (OECD) countries compared to over 70 PES articles in non-OECD countries. The findings also showed that the same barriers exist for Indigenous people throughout the globe with land tenure insecurity being the primary cause. I led the research including conducting key informant interviews, gathering relevant documents, and serving as the primary author of the article. My co-authors helped conceptualize the research, participated by analyzing the documents using our agreed upon method (Inductive Coding), and provided comments and revisions on the final article. The paper is published in *Ecosystem Services*.

AIM 2: Demonstrate the compatibility between Hopi and other Indigenous agricultural techniques and NRCS standard practices.

The research aim is addressed in one paper using three tribes as case studies of Indigenous “ways of knowing” in the area of conservation management with a heavy emphasis placed on Hopi and its agricultural management techniques.

Paper Title: Examining compatibility and conflicts in the integration of Indigenous Agricultural Knowledge into Natural Resource Conservation Service cost-share initiatives

This paper examines Indigenous Agriculture Knowledge (IAK) using three tribes as case studies: Hopi farmers, La Courte Band of Chippewa wild-rice harvesters, and Menominee foresters. We compared and contrasted IAK conservation methods with similar NRCS standard practices. A literature review was conducted using the words “Traditional Ecological Knowledge (TEK)” and “Indigenous Agricultural Knowledge.”

Although, TEK received a lot of hits, IAK was limited. We expand and refine the definition of IAK. The paper was written to demonstrate time-tested IAK methods produce similar conservation outcomes as the NRCS standard practices found in the Field Office Technical Guide. We provided justification as to why IAK method based practices should be accepted by NRCS. I led the research by gathering pertinent information on the tribes mentioned, analyzing the literature found, and serving as the primary author of the article. Also, I am a traditional Hopi dryland farmer who has accumulated a vast amount of agricultural knowledge from over 40 years spent in my family's fields. My co-authors helped formulate and define my ideas, contributed to my organization of the paper, and provided revisions and comments on the paper. This paper is planned for submission to the *Journal of Soil and Water Conservation*.

AIM 3: Develop and provide information to initiate sound policy solutions for decision-makers who wish to adequately address conservation issues in areas where populations of Indigenous people live.

The research aim was addressed in one policy paper to address the barriers and offer policy solutions to those entities (e.g., NRCS) who wish to work in Indian Country in the United States and perhaps across the globe where appropriate (Appendix C).

Paper Title: The expansion of Natural Resource Conservation Service cost-share programs on American Indian reservations

The purpose of this paper was to examine the barriers associated with NRCS cost-share programs in the United States and offer policy solutions. The paper is based on prior research from my previously published paper: *Barriers to PES programs in Indigenous communities: A lesson in land tenure insecurity from the Hopi Indian*

reservation and a white paper: *Examining compatibility and conflicts in the integration of Indigenous Agricultural Knowledge into Natural Resource Conservation Service cost-share initiatives*. One of our policy solutions to address our aim was to implement a regionally based Indigenous Field Office Technical Guide. The purpose of the guide was to integrate IAK based methods/techniques for use in NRCS cost-share programs. I led the research, including looking at prior solutions, federal laws and regulations, synthesizing the information from my two previously mentioned works and serving as the primary author of the article. My co-authors helped conceptualize the paper, contributed advice on how it would be organized, and provided revisions and comments on the final article. The paper is planned to be submitted to the *Journal of Water and Soil Conservation*.

AIM 4: Address the problems of outreach to Indigenous communities in the areas of conservation to better serve the population.

To address this aim, an exhibit was developed and was displayed between April 14th, 2018 and June 29th at the Arizona State Museum in Tucson, AZ. The accompanying essay lays out the framework of the purpose of the exhibit, what it contains, and my future goals and objectives for agricultural initiatives in the Hopi community (Appendix D).

Exhibit Essay: The Resiliency of Hopi Agriculture: 2000 Years of Planting (Johnson, Guest Curator and Falk, Co-Curator, 2018).

The exhibit was developed as an outreach tool to show the importance of time-tested Hopi agricultural methods and the roles Hopi people have in Hopi Society. It also is an illustrated demonstration of the benefits the Hopi agricultural system has for Hopi

people. The exhibit presents numerous photos taken at my family's fields on the Hopi reservation from 2005 to 2015. It also contains various Hopi agricultural archival photos from various museums in the United States. I donated the photos to be included in the exhibit, developed the initial captions for the descriptions of the photos, led the initial presentation to get permission from the Hopi Cultural Preservation Office and am the lead-curator. My co-curator helped organize the photos, edited some of the language used, dealt with the Arizona State Museum administrative procedures and was a vital advocate to make sure the exhibit was shown.

REFERENCES

- Auerbach, C. F., & Silverstein, L. B. (2003). *Qualitative data: an introduction to coding and analysis*. New York: New York University Press.
- Belcourt, A. (2019). The hidden health inequalities facing Native Americans. (n.d.). Retrieved April 4, 2019, from <https://www.indianz.com/News/2018/01/29/annie-belcourt-the-hidden-health-inequal.asp>.
- Berkes, F. (2012). *Sacred ecology* (3rd ed.). New York: Routledge.
- Bernard, H. R. (2006). *Research methods in anthropology: qualitative and quantitative approaches* (4th ed). Lanham, MD: AltaMira Press.
- Calloway, D. H., Giauque, R. D., & Costa, F. M. (1974). The superior mineral content of some American Indian foods in comparison to federally donated counterpart commodities. *Ecology of Food and Nutrition*, 3(3), 203–211. <https://doi.org/10.1080/03670244.1974.9990382>.
- 18 U.S.C § 1151.
- Flick, U. (1998). *An introduction to qualitative research*. London; Thousand Oaks, Calif: Sage.
- General Accounting Office (2017). Environmental Quality Incentives Program. Retrieved January 25, 2019, from National Sustainable Agriculture Coalition website: <http://sustainableagriculture.net/publications/grassrootsguide/conservation-environment/environmental-quality-incentives-program/>.
- Johnson, M. K., Lien, A. M., Sherman, N. R., & López-Hoffman, L. (2018). Barriers to PES programs in Indigenous communities: A lesson in land tenure insecurity from the Hopi Indian reservation. *Ecosystem Services*, 32, 62–69. <https://doi.org/10.1016/j.ecoser.2018.05.009>.
- Kimmerer, R. (2013). *Braiding sweetgrass: Indigenous wisdom, scientific knowledge and the teachings of plants* (First ed.).
- Onsae, C. (2018, June 19th). *Drought on the Hopi Reservation: Little relief in sight as forecast calls for worsening conditions*. The Hopi Tutuveni, Volume 26, No. 9., Page 1.
- Ridley, D. (2012). *The literature review : A step-by-step guide for students* (2nd ed., Sage study skills). London: SAGE.
- Walker, R. E., Keane, C. R., & Burke, J. G. (2010). Disparities and access to healthy food

in the United States: A review of food deserts literature. *Health & Place*, 16(5), 876–884. <https://doi.org/10.1016/j.healthplace.2010.04.013>.

Yin, R. (2018). *Case study research and applications: Design and methods* (Sixth ed.).

APPENDIX A: BARRIERS TO PES PROGRAMS IN INDIGENOUS COMMUNITIES:
A LESSON IN LAND TENURE INSECURITY FROM THE HOPI INDIAN
RESERVATION

Johnson, M. K., Lien, A. M., Sherman, N. R., & López-Hoffman, L. (2018). Barriers to PES programs in Indigenous communities: A lesson in land tenure insecurity from the Hopi Indian reservation. *Ecosystem Services*, 32, 62–69.
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Barriers to PES Programs in Indigenous Communities: A Lesson in Land Tenure Insecurity from the Hopi Indian Reservation

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ABSTRACT

There has been significant study of barriers to implementation of payment for ecosystem services in Indigenous communities in less developed countries. These barriers include land tenure insecurity and lack of access to capital. However, there is no similar research in the Organization for Economic Cooperation and Development (OECD) countries. Our research fills this gap. We hypothesize that mismatches between the traditional land tenure regimes and institutional arrangements of Indigenous communities on one hand, and government sponsors of PES programs on the other hand, result in the lack of success of these programs. To test this hypothesis, we conducted a qualitative study of the Environmental Quality Incentives Program (EQIP) on the Hopi reservation in the United States. We answer two questions: (1) What barriers prevent Hopi ranchers and farmers from participating in incentive-based programs? (2) What institutional changes are necessary to permit Hopi farmer and rancher participation in EQIP? We analyzed primary documents and conducted key informant interviews. We conclude that land tenure is at the forefront of problems associated with administering PES programs in Indigenous communities. Without new approaches addressing the land tenure regimes in Indigenous communities, PES will continue to struggle on American Indian reservations and around the world.

Keywords: payment for ecosystem services, Indigenous communities, developing countries, Hopi, land tenure

1. Introduction

Payment for ecosystem services programs (PES) have become popular around the globe to address goals such as biodiversity conservation, climate change, and economic development (Clements et al., 2010; Engel et. al., 2008; Hrabanski, 2015; Wunder, 2013). PES is defined in this paper using Wunder's, (2005, p. 2) definition as: "a voluntary, conditional transaction with at least one seller, one buyer, and a well-defined environmental service." Many PES programs take place in Indigenous communities. However, PES programs are often unsuccessful in these communities for two reasons: 1) land tenure insecurity and 2) culturally inappropriate institutional arrangements (Barrena et al., 2014; Clements et. al., 2010; Cuni-Sanchez et al., 2016; Holland et. al., 2014; Rodríguez-Robayo, et al., 2016; Soul et. al., 2000). Culturally inappropriate institutional arrangements do not take into consideration the traditional governance structure and culture of the people they are serving. While there has been significant research to understand these challenges in less developed countries, there are few similar studies evaluating programs in developed countries. For example, a search of *Ecosystem Services* using the terms "payment for ecosystem services" and "Indigenous" returned 76 articles, of which none addressed the design of programs in the United States and only 2 addressed the design of programs in Organization for Economic Cooperation and Development (OECD) countries, a common method of categorizing developed countries. Therefore, there is a significant gap in knowledge about the success of PES programs in Indigenous communities in developed countries. Here, we investigate if land tenure insecurity and institutional design are barriers to implementing PES programs on Indigenous lands in the United States. To do so, we conducted an intensive qualitative

study of the application and outcomes of the Environmental Quality Incentives Program (EQIP; a federal, agricultural-based PES program) on the Hopi reservation in the southwestern United States. We hypothesize PES programs are not successful in Indigenous communities when there is a mismatch between traditional land tenure regimes and institutional governance structures. We address our hypothesis by analyzing Natural Resource Conservation Service (NRCS; the agency within the United States Department of Agriculture that administers EQIP) and Hopi documents relating to EQIP contracts; summary notes from Hopi EQIP contract holder meetings; and interviews with Federal, State, and Hopi Tribal governmental officials. We conclude with a discussion of similarities and differences in barriers between developed and less developed countries.

1.1. Land Tenure and Indigenous Communities

Multi-layered land tenure regimes are differentiated rights associated with land and are present on Indigenous lands used for crops, pasture, ‘wild’ foods, minerals, water access, and trees and forests (Udry, 2011). These types of regimes are common in Indigenous communities around the world in both developed (e.g. United States) and less developed countries (e.g. Ghana, Nicaragua, and Mexico) (Brewer, et al., 2016; Broegaard, 2005; Haenn, 2006; Gyasi, 1994). Haenn found in Mexico that *Ejidors* (communal lands typically inhabited by Indigenous communities) are classified as village, farm, or common land, with different rights and obligations associated with each land classification. Törhönen, (2004) conducted a review of land tenure arrangements in four Indigenous communities in developing countries. The review demonstrates, in areas where multi-layered land tenure regimes exist, institutional governance structures are often fragmented, leading to myriad governance inequities.

In the United States, Indigenous land ownership is split across an array of land tenure regimes that include private ownership, communal ownership, and a range of common pool access institutions (Frye, 2012). A small body of literature has documented that land tenure insecurity is a problem for native nations in the U.S.; this results in direct economic and ownership insecurity for Indigenous people because they do not have absolute title of the land on which they reside (Akee & Jorgensen, 2014; Anderson & Hill, 1975; Brewer et al., 2016; Shoemaker, 2003).

There are three common types of land tenure on Indigenous lands in the U.S. (Table A1). Trust land is the most common land tenure regime. Under this type of land tenure, the land is held in trust by the federal government and its use is administered by the tribal government. The second common land tenure regime is allotted land, which is land held in trust by the federal government for individual tribal members. Allotted land is problematic because the land is divided between heirs, resulting in multiple owners of the same piece of land (Shoemaker, 2003). For example, on the Hopi reservation, it is possible to find a single acre of allotted land with as many as 100 individual heirship members all having ownership rights. Private land ownership (fee lands) is also common. Fee lands are owned by the tribal government or individuals and subject to the taxes and laws of non-Indian governments.

Table A1: American Indian Land Tenure Classifications

Land-Tenure Class	Definition
Tribal Trust Land	Land held in trust by the federal government for the entire tribe
Allotted Land	Land held in trust by the federal government for the benefit of an individual Indian
Fee Land	Land that is held in fee simple and not in trust
Clan Land	Land controlled by the different religious societies for customary use.
Village Land	Land controlled by the village

There are two additional land tenure regimes on the Hopi reservation that are unique to Hopi: clan lands and village lands (Table A1). These Hopi traditional land tenure regimes predate private property in the United States by at least 1000 years (Anderson and Lueck, 1992). Clan lands are controlled by traditional clan leadership for customary use. For example, in villages such as Shungopavi, those who wish to farm outside the village must seek the approval of the clan leadership to use the land (Forde, 1931). Village lands are controlled by the village government. For example, Hopi people who wish to build a house in Kykotsmovi must have a land assignment that has been approved by the village governor and village board.

Clan and village lands further complicate the implementation of PES programs on the Hopi reservation. Clan and village lands are within the boundaries of Hopi tribal trust land and the Hopi tribal government also has jurisdiction over these lands. Therefore, management of lands may require multiple levels of approval. For example, tribal livestock owners need approval from village and/or clan leadership and tribal government permits. In addition, PES implementation on village and clan lands requires approval from the Bureau of Indian Affairs (BIA), the federal agency responsible for management of tribal trust lands.

1.2. Culturally Inappropriate Institutional Arrangements

Culturally inappropriate institutional arrangements are also a barrier to Indigenous communities participating in PES programs. Challenges with implementation of PES programs occur when the different jurisdictional and land governance perspectives of Indigenous communities (e.g. land stewardship, customary use, and land held in common) are placed against non-Indigenous perspectives of land management and

ownership (e.g. private property and commodification of nature). Land tenure insecurity conflicts can impact who benefits from PES programs financially (Grima et al., 2016; Murillo et al., 2014). Financial benefits from PES programs often go to the leader of the Indigenous community, thus leaving other community members marginalized and divided with no direct economic gain from PES programs (Graddy-Lovelace, 2017; Osborne, 2013).

Kumar & Kumar (2014) show that cultural underpinnings are needed to make PES programs more effective on Indigenous lands. Most Indigenous people view nature as sacred and therefore are directly tied to the nature and ecosystems they are a part of. Indigenous people are just now beginning to have a direct impact on the implementation and administration of PES programs (Cuni-Sanchez et al., 2016; Guerra, 2016; Kumar & Kumar, 2014). Sattler et al. (2015) find that community management is a prerequisite to culturally appropriate institutional arrangements of PES programs in at least one Indigenous community, Maruja, in south-eastern Brazil. The resulting co-management agreements took into consideration Maruja values and allowed them to continue to reside in their home territories. Nonetheless, cultural identification and traditional Indigenous forms of governance are often overlooked in the design, administration, and assessment of PES programs (Mann et al., 2015).

Hopi people believe they are stewards of the land, not owners. The clan takes responsibility for their land through practices dedicated to ensuring the land will continue to produce the things they need such as crops and ceremonial plants. The Hopi believe they are directly tied to the land not only from the things the land produces but also believe the land is a direct reflection of the who they are as people. The Hopi forms of

land governance, such as clan and village land holdings, are not much different than how land is managed by Indigenous people throughout the world.

1.3. Environmental Quality Incentives Program

In this paper, the Environmental Quality Incentives Programs (EQIP) is used to evaluate implementation of PES on Indigenous lands in the United States. EQIP is a voluntary conservation program administered by NRCS to help agricultural producers achieve production and environmental quality goals. Through EQIP, agricultural producers enter into contracts with the U.S. federal government to receive financial and technical assistance in return for implementation of structural (e.g. livestock pipelines and windmills) and management conservation practices (e.g. soil supplementation and rotational grazing) that optimize environmental benefits on working agricultural land (NRCS, 2017). Scholars consider EQIP a PES program because it provides a direct payment to individual farmers in return for implementation of management practices that provide specific ecosystem services (Ma et al., 2010; Wunder et al., 2008). The 2012 USDA Census of Agriculture (the most recent data available) shows there are 58,475 American Indian farms (crops and livestock) in the United States. There were only 771 EQIP contracts for the implementation of conservation practices in 2013 (Barry Hamilton, NRCS National Tribal Liaison Officer personnel communication, February 27, 2018).

The Hopi reservation consists of 1.6 million acres, 1.4 million of which is used for livestock production and Hopi traditional dryland farming (Ashley, 2016). The Hopi reservation was created by an Executive Order in 1882 (Ashley, 2016). However, unlike most American Indian tribes in the United States, the Hopi people were allowed to

inhabit their traditional homelands in the areas conducive to dryland farming and subsequent Hopi villages established. Sixty-one percent of the households on Hopi are below the United States poverty level (Ashley, 2016).

Our goal here is to understand if an Indigenous community in a developed country experiences similar barriers to engagement in PES programs as are found in less developed countries across the globe. One might argue that Indigenous communities in developed countries do not face the same challenges with land tenure insecurity and culturally inappropriate institutional arrangements due to higher standards of living, democratic institutions, and strong property rights institutions. However, there is no evidence to evaluate this claim and the ability of Indigenous communities in developed countries to engage in PES programs has not been adequately studied. On the Hopi reservation in the United States, we hypothesize that both complex land tenure regimes and traditional Indigenous forms of governance have been overlooked in the design and implementation of the EQIP PES program. Similar to cases in less developed countries, this results in much needed natural resource conservation on Native American lands going unfulfilled.

2. Materials and Methods

This research aims to answer two questions: (1) What are the barriers that prevent Hopi ranchers and farmers from participating in incentive-based programs, such as EQIP? and (2) What institutional changes are necessary within the Hopi tribal government and NRCS to permit Hopi farmers and ranchers to fully participate in EQIP? To address these questions, we analyzed NRCS annual reviews for EQIP contracts on the Hopi reservation; Hopi individual and village cancellation letters; summary notes from

Hopi EQIP contract holder meetings; and interviews of Federal, State, and Hopi Tribal governmental officials. An inductive coding method was then used for both the documents and interviews to generate themes (Auerbach and Silverstein, 2003; Bernard, 2006; Flick, 1998).

2.1. Documents

The documents used for this study were NRCS annual reviews, cancellation letters, and Hopi EQIP project meeting notes from Hopi EQIP participants. NRCS annual reviews are meetings between the assigned District Conservationist and the EQIP contract holder to evaluate the progress of contract implementation. They contain required documentation, such as written approval letters and conservation plans. Cancellation letters describe the reasons for the termination of an EQIP contract. Cancellation letters were written by the Hopi EQIP contract holders for their various projects. Project meeting notes are notes taken during meetings between Hopi contract holders and NRCS. Taken together, annual reviews, cancellation letters, and project meeting notes provide significant data on the concerns of Hopi EQIP contract holders. For the present study, thirteen documents (6 annual reviews, 3 cancellation letters, and 4 project meeting notes) were analyzed. The documents dated from 2003 to 2004 and represent all of the EQIP contracts present on the Hopi reservation during those years and is the primary source used in our document analysis. Currently, there are no EQIP contracts on the Hopi reservation.

2.2. Interviews

Key informant interviews (Bernard, 2006) were conducted with NRCS and United States Department of Agriculture (USDA) officials (10), Bureau of Indian Affairs

(BIA) officials (1), Hopi representatives of the tribe's Office of Range Management (ORM) (2), and Hopi Conservation District (HCD) representative (1). A total of fourteen interviews were conducted between 2012 and 2013. We used a purposive sampling method to select interview respondents, selecting only those individuals who were familiar with the EQIP program at Hopi. The small sample size for the interviews with Hopi tribal officials (2) and a conservation district board member (1) was because these respondents were the only tribal members familiar and directly involved with the administration of EQIP on Hopi lands. USDA officials at the national and state level who had general knowledge of USDA programs on Indian reservations were also included. We used a semi-structured interview method (Bernard, 2006). We asked a range of questions focused on the barriers that prevent Hopi participation in programs such as EQIP and also pursued unique lines of questioning related to issues raised by specific respondents. The interviews were conducted in person or by telephone. Depending on how much information the participant was willing to provide, each interview lasted from 30 to 60 minutes. Notes were taken during the process of the interview for use during analysis. Interviews were not recorded due to concerns about respondent privacy.

We did not interview contract holders for this study because the primary documents, including cancellation letters, annual reviews, and project summary notes, provide detailed information on the challenges and barriers associated with EQIP implementation on Hopi lands. The information contained in the primary documents was taken directly from the words of the Hopi contract holders and therefore is an accurate representation of their perspectives.

All of the Hopi tribal members who participated in EQIP projects during the period of this study are represented in the documents. Given the challenges of gathering information on American Indian lands like the Hopi reservation, we believe our approach provides a critical insight into the research questions addressed by this paper, which would otherwise be impossible to obtain.

All interviews were conducted in accordance with policies and procedures of the Hopi Tribe under research permit License No. 12-006. The University of Arizona's Human Subjects Protection Program Institutional Review Board granted an exempt review and no further action was necessary to approve the research. All the information obtained from interview transcripts and documents was anonymized using a standardized numbering system so the name of the EQIP project, the Hopi contract participants, and the federal and tribal officials could not be linked to coded data.

2.3. Inductive Coding

An inductive coding method was employed to extract thematic data from primary documents and key informant interviews (Auerbach and Silverstein, 2003; Bernard, 2006; Flick, 1998). Our initial hypothesis, based on prior research that examined barriers to participation in government programs in Indian country (Shoemaker, 2003; Sutton, 1975; Trospen, 1978), was that mismatches between the cultural traditions and institutional settings of Indigenous communities and the governmental and non-governmental sponsors of economic incentives for natural resources conservation, especially land tenure arrangements, result in failure of current incentive-based approaches in Indigenous communities. Inductive coding was used to interrogate this hypothesis.

Land Tenure Issues, Lack of Capital, Lack of Communication, and Institutional Design Flaws were the four major themes identified in our analysis. Within these four major themes, we had several subthemes consisting of Untimely Project Implementation Delay, Not Understanding the Contract, Multiple Signatory Contract Issue, Irrigation Dilemma Hopi Farming, Burden of Taxes, Lack of Oversight, and Congressional Fixes (Table A2). After a first round of coding was completed, a reanalysis was done to identify additional information that may have been overlooked or inconsistently coded across sources (Auerbach and Silverstein, 2003).

Table A2: Themes, Subthemes (in italics), and Definitions used for coding.

Themes and Subthemes (italics)	Definitions
Land Tenure Issues	Problems associated with the administering of EQIP contracts on Tribal Trust or Allotted Lands due to land ownership status.
<i>Multiple Signature Issues</i>	Problems arising from EQIP projects where more than one signature is required per contract.
Lack of Capital	Problems associated with project implementation due lack of capital resources such as labor, equipment, and materials.
<i>Burden of Taxes</i>	Problems directly associated with cost-share reimbursements to EQIP participants arising from a rise in taxable income.
Lack of Communication	Problems directly stemming for systematic breakdowns of communication between all parties involved in the administrative and implementation of EQIP contracts.
<i>Untimely Project Delays</i>	Problems causing implementation delays on EQIP contracts such miscommunication regarding administration guidelines.
<i>Not Understanding the Contract</i>	Problems stemming from Hopi individual participants not understanding the EQIP contract language.
Institutional Design Flaws	Problems resulting from bureaucracy associated by the different agencies involved in the EQIP process.

Intercoder reliability testing was used to ensure consistency of coding using first and second cycle methods (Saldaña, 2009). For reliability, all data were coded independently by two of the authors (Johnson and Robbins-Sherman). Author Johnson established initial themes after an initial review of the data. After the themes and their definitions were established and agreed upon, Johnson and Robbins-Sherman independently coded all the data. Following coding, a third person (Lien) helped reconcile conflicts between the two coders. This process brought more clarity to the coding and identification of themes in the documents. As a result of the intercoding reliability process, we added a fourth major theme, Institutional design flaws and one subtheme, Congressional fixes.

3. Results

Table A3. shows the four major themes found in our study: Land Tenure Issues (59%), Lack of Capital (59%), Lack of Communication (74%), and Institutional Design Flaws (52%). The themes show a closely related group of institutional barriers that provide an explanation on why Hopi EQIP contracts were phased out and subsequently closed/canceled. This evidence supports our hypothesis that PES programs fail in Indigenous communities when there is a mismatch between traditional land tenure regimes and institutional governance structures.

Table A3: Types and Frequency of Documents and Interviews Analyzed

	Sources	#Items	Land Tenure	Lack of Capital	Lack of Communication	Institutional Design Flaws
Documents	Contract Holder Annual Reviews	6	5	6	6	0
	Contract Holder Cancellation Letters	3	2	2	3	0
	Contract Holder Project Meeting Summary Notes	4	4	4	4	0
Interviews	USDA Interviews	5	3	2	2	5
	NRCS Interviews	5	2	1	2	5
	BIA Interviews	1	0	0	1	1
	Tribal Official/Representative	2	0	0	1	2
	Hopi Conservation District Board Representative	1	0	1	1	1
	Total	27	16	16	20	14

3.1. Land Tenure Issues

Our study shows stark differences exist between Hopi tribal members and USDA officials on how they perceive Land Tenure Issues. The majority of contract holder documents noted specific concerns (11 of 13), while less than half of the officials interviewed pointed to specific Land Tenure Issues (5 of 14). Contract holders focused on the issues that would have a direct impact on completion of a contract. Federal officials knew about the problems of land tenure but referred to them as jurisdictional problems. For example, contract holders were clearly frustrated when one of them mentioned in his annual review, “if I do proceed with my contract I will ... also now need written permission from the tribe.” This is in contrast to USDA and NRCS officials who looked at land tenure as a mere “navigational issue.” They were not directly involved in the EQIP project on-the-ground and, though aware of some of the administrative problems caused by issues surrounding land tenure, they were reluctant to address them.

Land tenure is the most important barrier associated with implementation of EQIP projects on the Hopi reservation because it is linked to all other identified themes. For

example, if one does not have complete title to the land, as is typical with the land tenure regimes found on American Indian lands, then the land tenure arrangement is incompatible with the design and expectations of the EQIP program (Table A1). EQIP is designed for private land owners with secure title to the land.

One way land tenure issues manifest themselves is that NRCS must have written permission from the land owner and also the contract participant in order to approve the EQIP conservation plan, contract and subsequent modifications to the contract. One of the Hopi participants during his annual review mentioned, “he had a grazing permit from the area but no written permission from the Hopi Tribe to actually implement the applied practices.” Land Tenure Issues on Hopi are complicated by who has jurisdiction over the land in question. For example, if the land area is Village Land, then the village government must grant approval to use the land. Depending on the classification, different entities would be required to grant permission.

In addition, we identified a subtheme of Multiple Signature Issues. The subtheme appeared in 5 out of the 27 sources for our study. Modification of an EQIP contract requires all of the original contract holders’ signatures. Without all of the signatures, the contract cannot move forward unless it is modified by NRCS. In one case, project meeting summary notes stated that, “[NRCS was] informed that two of the original twelve contract holders had passed away and that three others sold their cattle and were no longer interested in the project.” Because two contract holders had passed away and three others no longer wanted to participate, modification of the original contract was difficult. Multiple signature issues also arise on allotted land. Over time, allotted land was

passed down and divided by heirs of the original allottees. As result, EQIP contracts require all owners' signatures.

3.2. Lack of Capital

Lack of Capital was the second common theme identified in our study. Monetary capital is required for material, cost of equipment, and labor for the implementation of EQIP projects. EQIP is a cost-share program, which means only a portion of the cost of EQIP practices are paid by the federal government. In addition, no payments are made until practices are completed and certified.

While non-Indian farmers may use their land for collateral in order to obtain loans, American Indian farmers and ranchers are unable to do so because their lands are held in trust by the federal government and therefore unavailable as collateral to individual American Indian producers (Anderson & Lueck, 1992). Lack of Capital issues appeared in 11 out of the 13 documents. Officials mentioned capital issues in only 4 out of the 14 interviews. The Lack of Capital also included the Burden of Taxes subtheme (2 of 27). Tax burdens were associated with cost-share payments for the individual Hopi contract holder.

Most contract holder documents stated the participants did not have the money to buy materials needed to initiate and complete installation of a conservation practice. During a contract holder annual review, it was noted by the participant, "it was his understanding at the time of signing the Hopi Tribe would provide the materials and he would supply the in-kind labor." Another EQIP participant raised concerns during an annual review about having enough money to complete the work.

Another area of concern in regards to the Lack of Capital was taxes associated with the reimbursement of cost-share payments to the contract holder. EQIP payments are considered taxable income. A Hopi tribal official stated in an interview that some of the Hopi EQIP participants were worried that cost-share reimbursements would increase their income tax burden. For the average Hopi person, any reduction in income would have a direct negative impact on necessary purchases, such as food, due to high rates of poverty.

Interviews with USDA and NRCS officials showed they were aware of the Lack of Capital, but only made references to helping contract holders by stating, “NRCS could put up the 30% upfront cost to start NRCS EQIP projects under the 2008 Farm Bill.” Interestingly, officials who were at the tribal level made no mention of the lack of capital. Based on the interviews, it appears Tribal officials were unaware of the amount of capital needed to start and finish EQIP projects because they did not know how many EQIP contracts were initially signed. The Hopi tribal officials only knew of the contracts approved by the tribe.

USDA and NRCS officials viewed Lack of Capital from a top down perspective. For example, a USDA official said, “the overall economy on reservations was not good.” This indicates that the official was aware of the lack of capital but not in the depth of detail needed to see it from the point of view of the Hopi contract holder. The interviewers were not the contract signees, so their involvement did not impact them financially. Contract holders became frustrated with the EQIP implementation process and some even initiated cancellation letters because their contracts were 3 to 4 years old: “Too much time has expired on the contract causing price inflation so therefore I will not

have all my practices completed as indicated in the original contract.” Unlike the officials interviewed, Hopi contract holders were directly impacted by what was happening in terms of contract fulfillment at the on-the-ground level.

3.3. Lack of Communication

Lack of Communication was caused by the way information was distributed by various federal officials to the Hopi Tribe and individual Hopi participants. We identified several communication issues between Hopi contract holders and officials from the USDA, NRCS, BIA, and the Hopi Tribe. Contract holders did not fully understand the NRCS documents and contracts. Lack of Communication issues appeared in 13 of 14 contract holder documents and half of the interviews (7 of 14).

Communication issues identified in documents resulted from misunderstandings about project approvals and contract language (10 of 27). For example, one Hopi contract holder was frustrated because it was communicated to him that the Hopi Tribe had granted him permission for his project when that was not the case. He said in his annual review, “I was disappointed that the tribe was unaware of this particular contract and indicated in all probability [NRCS Official] did not gain the proper approval from the tribe to proceed with this contract in a timely fashion.” Contract holders were also unaware of the language contained in the contract. A contract holder cancellation letter stated, “We were never properly informed by your past agency representative of what the contract contained...” Similar statements concerning contract holders not understanding what they signed were also found in the annual reviews (3 of 6) and project summary meeting notes (4 of 4).

Interviewees also referenced communication problems. These communication issues resulted in project delays. During an interview with a tribal official, she stated, “communication with NRCS was lacking especially in the area of educating Hopi farmers and ranchers about EQIP.” Some of the communication had to do with mistrust. A USDA official stated, “There is still mistrust between the agency and the tribes.” In essence, NRCS, USDA, and BIA officials did not talk to each other internally and they did not talk to the contract holders about the status of EQIP contracts. Communication delays were often blamed on interagency issues: “NRCS has a lack of understanding the BIA fiduciary responsibility it has with the tribes.” Although half of those interviewed indicated there were problems with communication, there seemed to be a reticence about how to address the issue.

Hopi tribal members experienced lack of communication as miscommunication between the Hopi Tribe and contract holders. A contract holder in his annual review stated, “I indicated that I had not heard back from a tribal official to get a cost estimate on the well mentioned in the contract.” In contrast, officials characterized Lack of Communication as a problem occurring between agencies. For example, a USDA official interviewed stated, “...how relationships can be better off as well as communication with tribes if the Contractual Working Agreements (CWA) between NRCS and tribes would be reviewed every year, because tribal governments change...”

3.4. Institutional Design Flaws

Institutional Design Flaws were issues associated with the administration of EQIP on the Hopi reservation. These included items such as the approval process for EQIP contracts, and in some cases their actual implementation. All of those interviewed for this

study directly or indirectly attributed some of the barriers to the problems associated with the design of the EQIP program and the difficulty of enrolling land with communal ownership. In contrast, Hopi tribal members did not mention any Institutional Design Flaws.

An example of an Institutional Design Flaw is the lack of interagency cooperation to approve conservation plans. For example, a NRCS official when interviewed talked about how a Memorandum of Understanding (MOU) was needed because of an interagency problem with the BIA. The BIA has Congressional authority to administer all land improvement practices on federal trust land associated with Indian reservations. As a result of the length of the approval process, some of the Hopi EQIP contracts could not move forward and were subsequently canceled.

Lack of oversight also resulted from Institutional Design Flaws. Lack of oversight is in reference to an agency's ability to monitor what is happening with the contracts and if they are effective in addressing resource concerns. During one interview with a USDA official, when asked if any studies were done on the effectiveness of EQIP contracts on Indian lands, the official responded by saying that they were not aware of any General Accountability Office (GAO) studies or Economic Research Service (ERS) studies. Similarly, a NRCS official also mentioned that no studies were done to demonstrate the effectiveness of EQIP contracts: "No program review was ever done by the state office on Hopi."

As previously noted, there was no mention of Institutional Design Flaws in the contract holder documents. Hopi contract holders were less concerned about what was happening above them than with their own EQIP projects. In contrast, those who were in

charge of administration of EQIP contracts seemed very bureaucratic. An example of the bureaucracy can be seen in an interview with a USDA official: “Tribal conservation districts need to be more active to try to stick something in or have congress approve funding for conservation districts.” This response was typical of other officials during our interview process.

4. Discussion

There has been significant research showing that traditional land tenure systems and institutional arrangements are a barrier to successful implementation of PES programs in less developed countries (Clements et. al., 2010; Rodríguez-Robayo, et al., 2016) However, there has been little study of this issue in OECD countries. We address this gap by studying a PES program, EQIP, on an Indigenous community (Hopi) in the United States. We hypothesized that the traditional land tenure regimes and institutions of Indigenous communities are poorly matched to PES programs, impeding PES program success. Our results show that Lack of Capital, Lack of Communication, and Institutional Design Flaws resulted in unsuccessful implementation of the EQIP PES for the Hopi people. Land Tenure Issues are related to each of these challenges. Further, these barriers in the U.S. are similar to those that have been identified in less developed countries. We discuss each of these barriers in succession and their relationship to similar issues in less developed countries.

4.1. Lack of Capital

EQIP is designed for private property owners who have the capital and land necessary to administer and then complete a contract with the federal government. EQIP contracts are issued on a cost reimbursable basis – the contract signatory must implement

the project to specifications before receiving payment (NRCS, 2017). However, traditional land tenure regimes do not grant individual titles to the land; tribal lands are not available as collateral to raise capital to enable implementation and maintenance of projects (Brewer et al., 2016). Cost-share PES models perform poorly in the context of this type of land tenure insecurity. And, as is typical of PES programs, EQIP requires participants to maintain practices over time even if payments are not continuous (Hayes, 2012; Wunder et al., 2008). Persistent poverty in Indigenous communities in both the U.S. and other countries make it unlikely that individuals will have the capital to implement practices required to receive a PES payment without pre-payment or other capital support (Dinsa et al., 2012; Snipp, 1992). Proponents of PES programs must address this issue by modifying program payment terms in order to increase access and participation in Indigenous communities.

USDA's 2501 program, *Outreach and Assistance for Socially Disadvantaged Farmers and Ranchers and Veteran Farmers and Ranchers Program* is designed to help overcome economic challenges faced by Indigenous communities and other socially and economically disadvantaged producers. Producers eligible for USDA's 2501 can receive additional funding for the implementation of conservation practices, including a payment prior to implementation of conservation practices. The 2501 program is intended to increase access and participation in EQIP. However, this program is inadequate on Hopi because it does not overcome land tenure and institutional governance issues.

4.2. Lack of Communication

Scholars have found proponents of PES programs often fail to communicate the goals of PES programs, the contract process, or how programs fit with traditional

management practices and forms of governance to Indigenous ecosystem service sellers (Hejnowicz et al., 2014; Rodríguez-Robayo et al., 2016). In our research, we found that Hopi participants did not fully understand the contract language or project implementation requirements due the Lack of Communication. One solution offered by Brewer et al. (2016) to address communication challenges in the U.S. is the Federal Recognized Tribal Extension Program (FRTEP). FRTEP is focused on improving communication in Indigenous communities about problems resulting from land tenure insecurity and diverse cultural traditions. A model like FRTEP helps address communication issues by serving as an intermediary between Indigenous communities and PES programs and by providing information on how to access and participate in PES programs. FRTEP agents serve as liaisons to university, state and federal personnel who want to work within Native American communities. As a result, FRETTP has played a significant role facilitating access to EQIP and similar programs. NRCS should seek to work with FRETTP agents to improve the delivery of EQIP and other conservation programs. FRETTP may also be a model for assisting Indigenous communities with accessing PES programs. At the time contracts analyzed in this study were signed, no help was available to Hopi in regard to NRCS EQIP program delivery by FRETTP agents.

FRETTP is not the only model used for outreach to Indigenous communities. Fox (1994) examined Mexico's National Solidarity Program, which was designed to increase Indigenous peoples' role in the decision-making process of their various communities. The National Solidarity Program's National Indigenous Institute (NII) left the decision process to autonomous regional councils, which represented Indigenous populations (Fox, 1994). Though NII did not address environmental concerns at the time of its

establishment, it laid the groundwork for grassroots organizations to improve communication and solve institutional problems (Bruhn, 1996).

Rawlins and Westby (2013) provide another example of how improved communication can help with successful implementation of a PES program. They evaluated a program called the Fire Guardianship Project (FGP) located in the Caura community of Trinidad. FGP established fire trails to prevent the spread of forest fires. Caura community members' input was sought prior to the establishment of the PES scheme to help determine the threats to ecosystems in the valley and ways to improve wildfire management. The involvement of Caura community members in the development and implementation of the PES scheme resulted in a program that was accessible to the community and shows how local involvement can result in improved outcomes.

Studies of how Indigenous communities value ecosystem services show that individuals' perception of ecosystem services directly corresponds to their cultural values (Barrena et al., 2014; Chan et al., 2012; Cuni-Sanchez et al., 2016; Rodríguez-Robayo et al., 2016; Tengberg et al., 2012). In order to understand the cultural needs of a particular people, effective communication must be established before decisions about non-Indigenous management approaches are made. Participation by Indigenous communities directly involved in producing ecosystem services is a necessary component to successful implementation of PES programs.

4.3. Institutional Design Flaws

NRCS is unaware of how to implement contracts on lands held in common, such as village and clan lands. Similar challenges have been identified for PES programs in

Indigenous communities globally (Brewer et al., 2016; Hejnowicz et al., 2014; Loft et al., 2015; Mann et al. 2015; Sarkki, 2017). Mann et al. showed institutional design flaws are evident when solutions are based only on biophysical or economic incentives and do not take into account traditional forms of governance. As a solution, they stress the importance of incorporating cultural traditions and considering socio-political factors when designing PES programs for Indigenous communities.

More attention is needed on impacts of program design on participation by Indigenous communities in PES programs over time. Most research focuses on only ecological outcomes rather than the factors influencing participation of Indigenous communities (Hejnowicz et al., 2014; Inostroza et al., 2017; Kumar et al., 2014; Leimona et al., 2015; Murillo et al. 2014; Pittock et al., 2012). Murillo et al. conducted the first evaluation of the impacts of the Costa Rican Payments for Environmental Services program on Indigenous communities. The Costa Rican Program was founded in 1996 and had gone almost 20 years without an assessment of impacts on Indigenous communities. Their study found that the PES program supported significant capacity building in the Indigenous community evaluated. This study demonstrates the critical need for evaluation of PES programs. While Murillo et al. found that the Cost Rican program benefited Indigenous communities, our study shows significant problems with the implementation of EQIP on the Hopi reservation. Institutional design flaws can be avoided if similar studies are conducted regularly and on a global basis.

4.4. Land Tenure

Similar to other PES programs around the world, jurisdictional issues associated with land tenure cause myriad bureaucratic problems (Davis & Wali, 1994; Muñoz-Piña,

et. al., 2008; Osborne, 2013; Osborne, 2016). In the U.S., economic and ownership insecurity result in myriad challenges for Native American communities (Akee & Jorgensen, 2014; Anderson & Hill, 1975; Brewer et al., 2016; Shoemaker, 2003). Organizations such as the Indian Land Tenure Foundation (ILTF) have been formed specifically to explain the jurisdictional challenges associated with land tenure to the general public and U.S. government officials.

In the context of EQIP, NRCS's solution has been to issue large multi-signatory EQIP contracts that glaze over differences in land tenure regimes, management goals, and cultural traditions. However, this does not solve the problem. In the United States, Indigenous communities suffer from land insecurity because of the haphazard imposition of western property rights systems on top of traditional collective ownership systems (McChesney, 1990; Miller, 2012). This has resulted in a mixture of land tenure arrangements on tribal lands, few of which are consistent with what was anticipated by NRCS when it designed the rules for the EQIP program. Despite this, NRCS has attempted to implement an identical EQIP program in both non-Indigenous and Indigenous communities. This approach fails to recognize significant differences in tribal land tenure and cultural traditions. It is unreasonable, unfair and ineffective to expect Indigenous communities to adapt traditional systems of communal and individual land ownership to fit western institutional traditions for the sole purpose of gaining access to a PES scheme.

These issues are challenges, not just for EQIP, but for all PES programs that seek to provide Indigenous communities with conservation incentives (Cuni-Sanchez et al., 2016; Guerra, 2016). PES programs generally assume as a precondition for participation

that participants will have secure titles to the land they seek to enroll (Engel et al., 2008). Tribal members in the United States and Indigenous people around the world often lack secure land titles, making participation difficult (Broegaard, 2005; Donkor et al., 2014; Gyasi, 1994).

It is a mistake, however, to assume that Indigenous communities do not have property rights systems or means of establishing land security (Bailey, 1992). In order to adequately serve Indigenous community needs, PES program proponents must seek to understand the various Indigenous approaches to property rights and adapt PES programs to fit with the institutional context found on tribal lands. Brewer et al. (2016), developed a primer to better understand the land tenure complexities found in American Indian lands in the United States. Similar approaches are needed for PES programs seeking to incentivize conservation in Indigenous communities outside the United States. Failure to do so may result in failure to achieve the conservation and poverty reduction goals of PES programs (Adams et. al., 2004; de Francisco and Boelans, 2014; Katz, 2000; McAfee & Shapiro, 2010).

5. Conclusions

Our study provides an in-depth analysis of the challenges and barriers associated with implementation of a PES program (EQIP) in an Indigenous community (the Hopi Nation). The barriers identified in our study are also found in PES programs in less developed countries (Clements et al., 2010; Holland et al., 2014; Osborne, 2015). Without new approaches to address barriers such as Land Tenure Issues, programs like EQIP will continue to struggle in Indigenous communities on American Indian reservations and around the world.

Suggested solutions include modifying payment terms to lower upfront capital requirements, educating PES program proponents about the unique land tenure arrangements present on tribal lands to improve program administration and communication, and encouraging the creation of tribal extension programs modeled after FRTEP to provide Indigenous communities with information about PES programs. FRTEP is just one example on dealing with Indigenous populations in the United States. There are other organizations that deal with institutional governance issues and land tenure security, such as the Indian Land Tenure Foundation (ILTF) and First Nations Development Institute (FNDI).

Although, this paper focuses on institutional barriers to the successful initiation of PES programs on Indigenous lands using Hopi as a case study, there is also an underlying question of what Indigenous knowledge can bring in the areas of biodiversity, conservation, and climate adaptation if they are allowed to manage their own environmental services as in the past. Future studies are needed to further demonstrate the efficacy of Indigenous methods of conservation in agriculture in hopes of influencing institutions and administrative policies and improving access to PES programs by allowing Indigenous communities to place management in a culturally appropriate context.

References

- Adams, W. M., Aveling, R., Brockington, D., Dickson, B., Elliott, J., Hutton, J., Roe, D., Vira, B., & Wolmer, W. (2004). Biodiversity conservation and the eradication of poverty. *Science*, *306*(5699), 1146–1149.
- Akee, R., & Jorgensen, M. (2014). Property institutions and business investment on American Indian reservations. *Regional Science and Urban Economics*, *46*, 116–125. <https://doi.org/10.1016/j.regsciurbeco.2014.04.001>.
- Anderson, T. L., & Hill, P. J. (1975). The evolution of property rights: a study of the American West. *The Journal of Law and Economics*, *18*(1), 163–179.
- Anderson, T. L., & Lueck, D. (1992). Land tenure and agricultural productivity on Indian reservations. *The Journal of Law & Economics*, *35*(2), 427–454.
- Ashley, J. (2016). Hopi Tribe Comprehensive Economic Development Strategy 2015. <http://www.hopi-nsn.gov/wp-content/uploads/2016/09/Hopi-Comprehensive-Economic-Development-Strategy-Final-Draft-2016.pdf>.
- Auerbach, C. F., & Silverstein, L. B. (2003). *Qualitative data: an introduction to coding and analysis*. New York: New York University Press.
- Barrena, J., Nahuelhual, L., Báez, A., Schiappacasse, I., & Cerda, C. (2014). Valuing cultural ecosystem services: Agricultural heritage in Chiloé island, southern Chile. *Ecosystem Services*, *7*, 66–75. <https://doi.org/10.1016/j.ecoser.2013.12.005>.
- Bailey, M. J. (1992). Approximate optimality of aboriginal property rights. *The Journal of Law and Economics*, *35*(1), 183–198.
- Bernard, H. R. (2006). *Research methods in anthropology: qualitative and quantitative approaches* (4th ed). Lanham, MD: AltaMira Press.
- Brewer, J. P., Hiller, J. G., Burke, S., & Teegerstrom, T. (2016). A Primer: Extension, Indian Land Tenure, and Rangeland Limitations. *Rangelands*, *38*(1), 16–22. <https://doi.org/10.1016/j.rala.2015.12.002>.
- Broegaard, R. J. (2005). Land tenure insecurity and inequality in Nicaragua. *Development and Change*, *36*(5), 845–864.
- Bruhn, K. (1996). Social Spending and Political Support: The “Lessons” of the National Solidarity Program in Mexico. *Comparative Politics*, *28*(2), 151–177. <https://doi.org/10.2307/421979>.
- Chan, K. M. A., Guerry, A. D., Balvanera, P., Klain, S., Satterfield, T., Basurto, X., Bostrom, A., Chuenpagdee., Gould, R., Halpern, B.S., Hannahs, N., Levine, J.,

- Norton, B., Ruckelshaus, M., Russel, R., Tam, J., & Woodside, U. (2012). Where are Cultural and Social in Ecosystem Services? A Framework for Constructive Engagement. *BioScience*, 62(8), 744–756. <https://doi.org/10.1525/bio.2012.62.8.7>.
- Clements, T., John, A., Nielsen, K., An, D., Tan, S., & Milner-Gulland, E. J. (2010). Payments for biodiversity conservation in the context of weak institutions: Comparison of three programs from Cambodia. *Ecological Economics*, 69(6), 1283–1291. <https://doi.org/10.1016/j.ecolecon.2009.11.010>.
- Cuni-Sanchez, A., Pfeifer, M., Marchant, R., & Burgess, N. D. (2016). Ethnic and locational differences in ecosystem service values: Insights from the communities in forest islands in the desert. *Ecosystem Services*, 19, 42–50. <https://doi.org/10.1016/j.ecoser.2016.04.004>.
- Davis, S. H., & Wali, A. (1994). Indigenous land tenure and tropical forest management in Latin America. *Ambio*, 485–490.
- de Francisco, J. R., & Boelens, R. A. (2014). Why Power Matters in Payments for Environmental Services (PES). *Briefing Paper/German Development Institute, GDI, 2014(9)*. Retrieved from <http://library.wur.nl/WebQuery/wurpubs/fulltext/330429>.
- Dinsa, G. D., Goryakin, Y., Fumagalli, E., & Suhrcke, M. (2012). Obesity and socioeconomic status in developing countries: a systematic review: Obesity and socio-economic status in developing countries. *Obesity Reviews*, 13(11), 1067–1079. <https://doi.org/10.1111/j.1467-789X.2012.01017.x>.
- Donkor, E., Owusu, V., & others. (2014). Effects of land tenure systems on resource-use productivity and efficiency in Ghana's rice industry. *African Journal of Agricultural and Resource Economics*, 9(4), 286–299.
- Engel, S., Pagiola, S., & Wunder, S. (2008). Designing payments for environmental services in theory and practice: An overview of the issues. *Ecological Economics*, 65(4), 663–674. <https://doi.org/10.1016/j.ecolecon.2008.03.011>.
- Flick, U. (1998). *An introduction to qualitative research*. London; Thousand Oaks, Calif: Sage.
- Forde, C. D. (1931). Hopi Agriculture and Land Ownership. *The Journal of the Royal Anthropological Institute of Great Britain and Ireland*, 61, 357–405. <https://doi.org/10.2307/2843925>.
- Fox, J. A. (1994). Targeting the poorest: The role of the national indigenous institute in Mexico's national solidarity program. *Center for Global, International and Regional Studies*.

- Frye, D. D. (2012). Leasing, Law, and Land Tenure: Understanding the Impact of the Long-Term Leasing Act of 1955 on Indian Land Holdings. Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2181724.
- Graddy-Lovelace, G. (2017). The coloniality of US agricultural policy: articulating agrarian (in)justice. *The Journal of Peasant Studies*, 44(1), 78–99. <https://doi.org/10.1080/03066150.2016.1192133>.
- Grima, N., Singh, S. J., Smetschka, B., & Ringhofer, L. (2016). Payment for Ecosystem Services (PES) in Latin America: Analysing the performance of 40 case studies. *Ecosystem Services*, 17, 24–32. <https://doi.org/10.1016/j.ecoser.2015.11.010>.
- Guerra, R. (2016). Assessing preconditions for implementing a Payment for Environmental Services initiative in Cotriguaçu (Mato Grosso, Brazil). *Ecosystem Services*, 21, 31–38. <https://doi.org/10.1016/j.ecoser.2016.07.009>.
- Gyasi, E. A. (1994). The adaptability of African communal land tenure to economic opportunity: the example of land acquisition for oil palm farming in Ghana. *Africa*, 64(3), 391–405. <https://doi.org/10.2307/1160788>.
- Haenn, N. (2006). The changing and enduring ejido: a state and regional examination of Mexico's land tenure counter-reforms. *Land Use Policy*, 23(2), 136–146. <https://doi.org/10.1016/j.landusepol.2004.07.002>.
- Hamilton, B. (2017). Personnel Communication.
- Hayes, T. M. (2012). Payment for ecosystem services, sustained behavioural change, and adaptive management: peasant perspectives in the Colombian Andes. *Environmental Conservation*, 39(2), 144–153. <https://doi.org/10.1017/S0376892912000045>.
- Holland, M. B., de Koning, F., Morales, M., Naughton-Treves, L., Robinson, B. E., & Suárez, L. (2014). Complex Tenure and Deforestation: Implications for Conservation Incentives in the Ecuadorian Amazon. *World Development*, 55, 21–36. <https://doi.org/10.1016/j.worlddev.2013.01.012>.
- Hrabanski, M. (2015). The biodiversity offsets as market-based instruments in global governance: Origins, success and controversies. *Ecosystem Services*, 15, 143–151. <https://doi.org/10.1016/j.ecoser.2014.12.010>.
- Hejnowicz, A. P., Raffaelli, D. G., Rudd, M. A., & White, P. C. L. (2014). Evaluating the outcomes of payments for ecosystem services programmes using a capital asset framework. *Ecosystem Services*, 9, 83–97. <https://doi.org/10.1016/j.ecoser.2014.05.001>.

- Inostroza, L., König, H. J., Pickard, B., & Zhen, L. (2017). Putting ecosystem services into practice: Trade-off assessment tools, indicators and decision support systems. *Ecosystem Services*, *26*, 303–305. <https://doi.org/10.1016/j.ecoser.2017.07.004>.
- Katz, E. G. (2000). Social Capital and Natural Capital: A Comparative Analysis of Land Tenure and Natural Resource Management in Guatemala. *Land Economics*, *76*(1), 114. <https://doi.org/10.2307/3147261>.
- Kumar, P., & Kumar, M. (2014). Behavioural underpinnings of response policies for ecosystem management. *Ecosystem Services*, *10*, 125–127. <https://doi.org/10.1016/j.ecoser.2014.11.001>.
- Kumar, P., Kumar, M., & Garrett, L. (2014). Behavioural foundation of response policies for ecosystem management: What can we learn from Payments for Ecosystem Services (PES). *Ecosystem Services*, *10*, 128–136. <https://doi.org/10.1016/j.ecoser.2014.10.005>.
- Leimona, B., Lusiana, B., van Noordwijk, M., Mulyoutami, E., Ekadinata, A., & Amaruzaman, S. (2015). Boundary work: Knowledge co-production for negotiating payment for watershed services in Indonesia. *Ecosystem Services*, *15*, 45–62. <https://doi.org/10.1016/j.ecoser.2015.07.002>.
- Loft, L., Mann, C., & Hansjürgens, B. (2015). Challenges in ecosystem services governance: Multi-levels, multi-actors, multi-rationalities. *Ecosystem Services*, *16*, 150–157. <https://doi.org/10.1016/j.ecoser.2015.11.002>.
- Ma, S., Swinton, S. M., Lupi, F., & Jolejole, C. B. (2010). Why farmers opt not to enroll in payment-for-environmental-services programs. In *Selected Paper prepared for presentation at the Agricultural & Applied Economics Association's 2010 AAEA, CAES, & WAEA Joint Annual Meeting in Denver, July 25-July* (Vol. 27, p. 2010).
- Mann, C., Loft, L., & Hansjürgens, B. (2015). Governance of Ecosystem Services: Lessons learned for sustainable institutions. *Ecosystem Services*, *16*, 275–281. <https://doi.org/10.1016/j.ecoser.2015.11.003>.
- McAfee, K., & Shapiro, E. N. (2010). Payments for Ecosystem Services in Mexico: Nature, Neoliberalism, Social Movements, and the State. *Annals of the Association of American Geographers*, *100*(3), 579–599. <https://doi.org/10.1080/00045601003794833>.
- McChesney, F. S. (1990). Government as definer of property rights: Indian lands, ethnic externalities, and bureaucratic budgets. *The Journal of Legal Studies*, *19*(2), 297–335.
- Miller, R. J. (2012). *Reservation "capitalism": Economic Development in Indian Country*. ABC-CLIO.

- Molina Murillo, S. A., Pérez Castillo, J. P., & Herrera Ugalde, M. E. (2014). Assessment of environmental payments on Indigenous territories: The case of Cabecar-Talamanca, Costa Rica. *Ecosystem Services*, 8, 35–43. <https://doi.org/10.1016/j.ecoser.2014.02.003>.
- Muñoz-Piña, C., Guevara, A., Torres, J. M., & Braña, J. (2008). Paying for the hydrological services of Mexico's forests: Analysis, negotiations and results. *Ecological Economics*, 65(4), 725–736. <https://doi.org/10.1016/j.ecolecon.2007.07.031>.
- Natural Resource Conservation Service. (2017). Environmental Quality Incentives Program. Available at: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/financial/eqip/?cid=nrcs144p2_068634, accessed August 27, 2017.
- Osborne, T. (2013). Fixing carbon, losing ground: payments for environmental services and land (in) security in Mexico. *Human Geography*, 6(1), 119–133.
- Osborne, T. (2015). Tradeoffs in carbon commodification: A political ecology of common property forest governance. *Geoforum*, 67, 64–77. <https://doi.org/10.1016/j.geoforum.2015.10.007>.
- Osborne, T. (2016). State Forestry Incentives and Community Stewardship: A Political Ecology of Payments and Compensation for Ecosystem Services in Guatemala's Highlands. *Journal of Latin American Geography*, 15(1), 83–110.
- Pittock, J., Cork, S., & Maynard, S. (2012). The state of the application of ecosystems services in Australia. *Ecosystem Services*, 1(1), 111–120. <https://doi.org/10.1016/j.ecoser.2012.07.010>.
- Rawlins, M. A., & Westby, L. (2013). Community participation in payment for ecosystem services design and implementation: An example from Trinidad. *Ecosystem Services*, 6, 117–121. <https://doi.org/10.1016/j.ecoser.2013.09.004>.
- Rodríguez-Robayo, K. J., Ávila-Foucat, V. S., & Maldonado, J. H. (2016). Indigenous communities' perception regarding payments for environmental services programme in Oaxaca Mexico. *Ecosystem Services*, 17, 163–171. <https://doi.org/10.1016/j.ecoser.2015.11.013>.
- Saldaña, J. (2009). *The coding manual for qualitative researchers*. Los Angeles, Calif: Sage.
- Sarkki, S. (2017). Governance services: Co-producing human well-being with ecosystem services. *Ecosystem Services*, 27, 82–91. <https://doi.org/10.1016/j.ecoser.2017.08.003>.

- Sattler, C., Schröter, B., Jericó-Daminello, C., Sessin-Dilascio, K., Meyer, C., Matzdorf, B., Giersch, G. (2015). Understanding governance structures in community management of ecosystems and natural resources: The Marujá case study in Brazil. *Ecosystem Services*, 16, 182–191.
<https://doi.org/10.1016/j.ecoser.2015.10.015>.
- Shoemaker, J. A. (2003). Like snow in the spring time: Allotment, fractionation, and the Indian land tenure problem. *Wis. L. Rev.*, 729.
- Snipp, C. M. (1992). Sociological perspectives on American Indians. *Annual Review of Sociology*, 18(1), 351–371.
- Soule, M. J., Tegene, A., & Wiebe, K. D. (2000). Land tenure and the adoption of conservation practices. *American Journal of Agricultural Economics*, 82(4), 993–1005.
- Sutton, I. (1975). *Indian land tenure: bibliographical essays and a guide to the literature*. New York: Clearwater Pub. Co.
- Tengberg, A., Fredholm, S., Eliasson, I., Knez, I., Saltzman, K., & Wetterberg, O. (2012). Cultural ecosystem services provided by landscapes: Assessment of heritage values and identity. *Ecosystem Services*, 2, 14–26.
<https://doi.org/10.1016/j.ecoser.2012.07.006>.
- Törhönen, M.-P. (2004). Sustainable land tenure and land registration in developing countries, including a historical comparison with an industrialised country. *Computers, Environment and Urban Systems*, 28(5), 545–586.
<https://doi.org/10.1016/j.compenvurbsys.2003.11.007>.
- Trosper, R. L. (1978). American Indian Relative Ranching Efficiency. *The American Economic Review*, 68(4), 503–516.
- Udry, C. (2011). Land tenure. *The Oxford Companion to the Economics of Africa*, 1.
- Wunder, S. (2005). Payments for environmental services: some nuts and bolts. Occasional Paper. No. 42., *CIFOR*.
- Wunder, S. (2013). When payments for environmental services will work for conservation: When PES will work. *Conservation Letters*, 6(4), 230–237.
<https://doi.org/10.1111/conl.12034>.
- Wunder, S., Engel, S., & Pagiola, S. (2008). Taking stock: A comparative analysis of payments for environmental services programs in developed and developing countries. *Ecological Economics*, 65(4), 834–852.
<https://doi.org/10.1016/j.ecolecon.2008.03.010>.

APPENDIX B: EXAMING COMPATIBILITY AND CONFLICTS IN THE
INTEGRATION OF INDIGENOUS AGRICULTURAL KNOWLEDGE INTO
NATURAL RESOURCE CONSERVATION SERVICE COST-SHARE INITIATIVES

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Examining Compatibility and Conflicts in the Integration of Indigenous Agricultural Knowledge into Natural Resource Conservation Service Cost-Share Initiatives

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ABSTRACT

Over millennia, Indigenous people have crafted and refined techniques that enhance the sustainability and resiliency of the agroecosystems they manage. These techniques could benefit the United States Department of Agriculture's Natural Resource Conservation Service (NRCS) efforts to encourage sustainable practices in agriculture through cost-share programs, such as the Environmental Quality Incentives Program (EQIP) and the Conservation Stewardship Program (CSP). In the FY of 2017, only 1035 EQIP and CSP contracts out of 49,140 were awarded to American Indian operated farms demonstrating that there is clearly room for more EQIP and CSP contracts in "Indian Country." In 2010, NRCS released a guidebook, *Indigenous Stewardship Methods (ISM) and NRCS Conservation Practices* in an attempt to better integrate Indigenous Agricultural Knowledge (IAK) into the conservation programs. EQIP and CSP rely on 219 standard conservation practices detailed in the NRCS Field Office Technical Guide (FOTG), and previous studies have suggested that a key reason for the lack of Indigenous participation in NRCS programs is that Indigenous practices are not recognized in the FOTG. In this paper, we present Indigenous agricultural systems employed by Hopi dryland farmers, the La Courte Band of Chippewa wild-rice harvesters, and Menominee tribe foresters to demonstrate that these systems achieve results similar to NRCS standards practices, but they have significantly different philosophical foundations. Indigenous practices rely on holistic conservation management schemes that reflect deep cultural values embodied in time-tested practices and Indigenous concepts of stewardship, rather than the commodification of the natural world. While these philosophical differences complicate integration of Indigenous practice into NRCS programs, continued and enhanced efforts

to increase Indigenous participation will further NRCS' commitment to "Helping People Help the Land".

Keywords: Indigenous Agricultural Knowledge, Natural Resource Conservation Service, Traditional Agricultural Knowledge, Tribal Forestry, Wild Rice Harvesting, Hopi Dryland Farming

1. Introduction

Currently, about 99 million acres of land is under Indigenous control in the United States (55 million acres in the lower 48 United States and 44 million acres in Alaska) and according to the 2012 agricultural census, there are 37,851 American Indian owned farms and agricultural operations. Many of these lands are within ecologically sensitive and economically depressed regions of the country (Census Bureau 2018), which suggests that economic conditions may undermine conservation practices or conservation decisions may be secondary to potential economic development. Because these conditions exist on many reservation lands, Natural Resource Conservation Service (NRCS) cost share programs such as the Environmental Quality Incentives Program (EQIP) or Conservation Stewardship Program (CSP) may have significant effects on both the local economy and NRCS conservation goals. These conditions, combined with the limited number of EQIP and CSP contracts currently active on Indigenous lands, suggest there is significant opportunity to expand Indigenous participation in NRCS programs and by expanding Indigenous participation, NRCS will better achieve their conservation mission.

This paper examines three different Indigenous agricultural management regimes, including Hopi dryland farming, the La Courte Band of Chippewa wild-rice harvesting, and Menominee tribe forestry. These case studies demonstrate that management practices stemming from Indigenous Agricultural Knowledge (IAK) achieve many of the same conservation goals as NRCS standard practices, but they embody significantly different philosophical foundations that may complicate integration into EQIP and CSP. The comprehensive, place-based knowledge embodied in Indigenous systems is well suited to

addressing natural resource management and conservation concerns addressed by the United States Department of Agriculture's (USDA) NRCS (Berkes 1999; Cruikshank 2005; Nasady 2003; Nelson 1983; Menzies 2006; Pierotti 2011; Trosper 2009). However, the NRCS programs are little used on American Indian Lands. In 2010, publication of the *Indigenous Stewardship Methods (ISM) and NRCS Conservation Practices Guidebook* acknowledged the potential benefit and difficulty of incorporating indigenous management practices into the conservation programs (Leonetti 2010). However, in the FY of 2017, only 1030 EQIP and CSP contracts out of the 49,140 were awarded to American Indian operated farms (Hamilton 2018). This level of participation suggests that further incorporation of IAK into EQIP and CSP will further NRCS' overarching mission of "*Helping People Help The Land*".

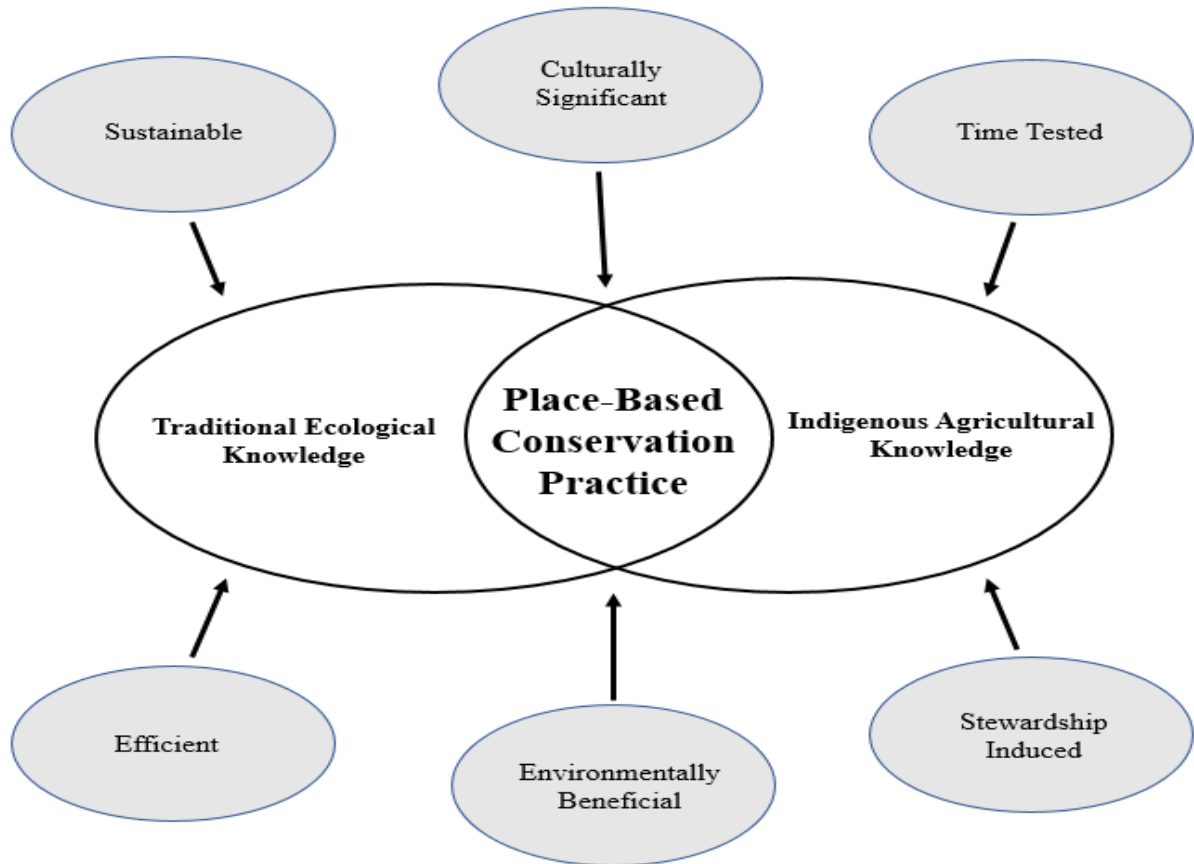
This paper proceeds as follows; First, we define and link Indigenous Agricultural Knowledge (IAK) to Traditional Ecological Knowledge (TEK), which is already employed in some management plans by federal agencies including the National Park Service (NPS) and the United States Forest Service (USFS). Second, we summarize the policy instruments and conservation mechanisms employed by NRCS and discuss the current state of Indigenous participation. We then present our methods and conservation management case studies from the Hopi tribe in Arizona, the La Courte Oreilles Band of Chippewa, and the Menominee tribe of Wisconsin. We follow with a discussion that highlights the common conservation outcomes and philosophical differences between Indigenous practices and the standard practices included in the NRCS Field Office Technical Guide (FOTG). We conclude by suggesting that the fundamental philosophical differences between NRCS and the Indigenous management examples may be

complicating the integration of IAK into EQIP and CSP, but continued efforts to integrate IAK will significantly benefit NRCS' conservation mission.

1.1. Place Based Indigenous Knowledge

Traditional Ecological Knowledge (TEK) is defined as “*a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmissions, about the relationship of living beings (including humans) with one another and their environments* (Berkes 1999 p.8)”. In this paper, we employ the term Indigenous Agricultural Knowledge (IAK), which follows the same definition as TEK, but is based on the generational knowledge developed by Indigenous agriculturalists. IAK recognizes the deep agricultural traditions among Indigenous populations, which are not typically acknowledged by TEK, and embodies the natural resource management techniques and conservation practices integrated into Indigenous agricultural systems. For the purpose of this paper, we defined IAK as applied knowledge for raising food and other agricultural products that is grounded in Indigenous belief systems and practices which have been time-tested over millennia. Both TEK and IAK contribute to Indigenous place-based conservation practices, which may be defined by 6 main characteristics: 1) sustainable, 2) culturally significant, 3) time-tested, 4) efficient, 5) environmentally beneficial and 6) stewardship induced (See Figure B1).

Figure B1: These 6 characteristics are embodied in TEK and IAK, which are the foundation of Indigenous place-based conservation practices.



Hopi dryland farmers and other Indigenous agriculturalists have deliberately shaped their methods and practices into a suite of place-based conservation practices. These agriculturalists are well-informed and knowledgeable practitioners that have successfully adapted and maintained agricultural systems through different environmental conditions using few inputs and local materials. Many of the practices are ingenious solutions to meeting the common problems of maintaining soil productivity and providing moisture necessary for successful crop production. Many of the methods and practices stemming from IAK include reading the landscape and working with the land

and environment to encourage and support agricultural production. Additionally, IAK has produced crops with unique genetic lines that are well-adapted to local conditions. We argue that the characteristics of these cropping systems could provide significant contributions to the NRCS mission.

1.2. Natural Resource Conservation Service Policy Instruments

The USDA primarily employs two policy instruments to meet the conservation goals in its mission; EQIP and CSP. The NRCS administers these cost-share programs, which can also be referred to as Payment for Ecosystem Services (PES) (Johnson et al. 2018). PES programs are “...*a voluntary, conditional transaction with at least one seller, one buyer, and well-defined environmental service* (Wunder 2005 p. 2).” EQIP is a voluntary conservation program that helps agricultural producers achieve production and environmental quality goals (NRCS, 2018). Through EQIP, agricultural producers receive financial and technical aid to implement structural and management conservation practices that optimize the environmental benefits of working agricultural land. The administration of CSP is similar to EQIP, except CSP is designed to enhance existing practices on agricultural working lands. Contracts under CSP must maintain the existing conservation practices based on the operation type and number of resource concerns that are meeting the stewardship level at the time of application and implement additional conservation activities (NRCS, 2018). EQIP contracts may last for no more than 10 years while CSP contracts are for a period of no more than 5 years.

To be eligible for EQIP or CSP funding, the participating agricultural producer’s land must have an identifiable resource management problem or concern, such as soil and water erosion. The applicant must be the owner or operator of eligible land, including

cropland, rangeland, pasture, nonindustrial private forestland, and other farm or ranch lands. The participant, with the help of the local NRCS district conservation office, first designs a conservation plan to better manage the natural resources on his or her farm. The conservation plan includes items such as an aerial photo or diagram of the fields, a list of management decisions, the location of and schedule for applying new conservation practices, a soil map and soil descriptions, information sheets explaining how to carry out specific management decisions, and, if needed, a plan for operation and maintenance of practices (NRCS 2018). Once a conservation plan is finished, it is evaluated by the local county District Conservation Board (DCB) comprised of farmers and ranchers from that particular district. The DCB reviews the conservation practices and the natural resource concerns in the proposal and makes funding recommendations based on ranking criteria. The NRCS state office gives final approval to EQIP or CSP contracts.

Conservation plans draw from 219 standard practices related to soil and water conservation listed in the National FOTG. Some of the practices included in the FOTG include planting herbaceous weed cover, channel diversion, employing cover crops, and using minimal tillage. Conservation practices are designed to “...*reduce the losses of soil, nutrients, pesticides, pathogens, and other biological and chemical materials from agricultural lands, conserve natural resources, enhance the quality of the agro-ecosystem, and enhance wildlife habitat* (NRCS 2018 p. 2).”

There are two conservation regimes funded by EQIP and CSP; structural and management. Structural conservation practices include projects such as the installation of livestock fencing, pipelines, and irrigation projects to optimize the conservation of water. For example, irrigation projects administered by EQIP help line canals with cement or

use pipelines to reduce water loss through seepage or evaporation. Livestock fencing helps reduce soil erosion caused by overgrazing by limiting the areas where cattle, sheep, and horses feed. Management aspects of conservation practices include rotational grazing and integrated cropping systems that preserve and enhance soil nutrients. Management practices also include herbicide and pesticide applications to control invasive species and noxious weeds.

1.3. Indigenous participation in NRCS conservation programs

Both institutional and structural barriers to Indigenous participation in NRCS programs have been identified (Johnson et al. 2018). PES programs like EQIP are often unsuccessful because of issues associated with land tenure insecurity and culturally inappropriate institutional arrangements (CIIA). Land tenure insecurity is associated with the classification of tribal lands (e.g. trust land, fee land, ceded land, village land or clan land) and who has final jurisdiction over those properties. CIIA is in direct correlation with forcing unfamiliar administrative policy on Indigenous societies without their input causing fractionalization within those communities. Other barriers which might also be considered are American Indian participant's lack of monetary capital to purchase the necessary infrastructure associated with NRCS cost-share initiatives. Another barrier is the lack of communication between federal, tribal and Hopi participants at all levels of contract administration, which resulted in EQIP contract failure due to delayed project implementation occurring from miscommunication (Johnson et al. 2018).

2. Methods

We draw information on Indigenous agricultural practices from case studies of three tribes in the United States (Hopi Tribe, La Courte Band of Chippewa, and

Menominee Tribe). We compare Indigenous agricultural practices to standard practices found in the NRCS FOTG to demonstrate that conservation practices developed through IAK achieve similar outcomes to NRCS standard practices. We selected the three tribes used in this study because they have significant chronological depth, information about their practices is readily available, and their philosophical approach to conservation is clear in their agricultural practice. All three tribes employ a holistic management approach, which includes a variety of conservation techniques that comport with and embody their cultural world views. Hopi dry-land agriculturalists employ a suite of planting and conservation techniques that allow them to grow crops, such as corn, beans, and squash in a semi-arid region without irrigation. The La Courte Band of Chippewa are known for their successful management and preservation of wild-rice stands. The Menominee tribe sustainably manage timber production guided by their cultural beliefs, although their management traditions are younger than the previous examples.

We conducted a literature review using the words: Hopi Agriculture, La Courte Band of Chippewa, Menominee, Traditional Ecological Knowledge, Indigenous Agricultural Knowledge, Sustainability, Holistic Management and Conservation. We specifically looked for discussions and descriptions of the conservation management techniques used by the three tribes in our study. We also draw heavily upon author Johnson's (Hopi Indian) four decades of experience as a dryland farmer, and the lessons and techniques from Hopi agriculture that were passed down to him from his father and grandfather in the form of generational knowledge developed over millennia. This review and first-hand knowledge form the basis of the case studies presented in this paper.

We then reviewed specific management practices from our case studies and attempted to link them to NRCS standard practices in the FOTG based on the intended conservation outcomes. We describe the techniques employed by the indigenous agriculturalists, the conservation outcome, and then provide the specific NRCS code for practices in the FOTG that achieve similar outcomes.

3. Tribal Case Studies

The following section provides some historic and geographic context for each of the case studies and a description of the management techniques employed in the agricultural system. We also present some of the cultural and philosophical foundations and connections to the tribes' belief systems that are embodied in the techniques and management decisions. The studies presented here are not intended to be exhaustive reviews of each of the agricultural systems, rather they are meant to provide examples of some specific management practices and the connection of those practices to tribal belief systems.

3.1. Hopi Dryland Agriculture

The Hopi reservation consists of 647,497 hectares of semi-arid land in northern Arizona (Tiller 2015). Through time, Hopi farmers have learned to adapt to growing different varieties of crops, such as corn, beans, squash, melons and cotton in an area which only receives 14.2 to 25.4 centimeters of annual precipitation (Singletary et al. 2014), whereas conventional agriculture recommends 83.8 centimeters of precipitation or supplemental irrigation for these crops (Tannura 2007). Innovative dry-land farming and resource conservation techniques used by Hopi farmers have been well documented (Dominguez & Kolm 2005) and evidence of Hopi dry-land farming techniques and

conservation methods is found in both the ethnographic and archaeological record, demonstrating that versions of this agricultural system has been practiced for over 2000 years (Hough 1897; Stewart 1940).

Our average field size is .04 to 2.02 hectares, which we locate near rock outcroppings so runoff from monsoon storms can easily be directed to the fields by natural and man-made check dams and channels to bring nutrient rich soil to the field. Typically, we clear fields in February as weeds are easily removed and little disturbance is done to the soil. We use readily available plants, such as brush and wild grasses and apply them as windbreaks (Figure B2). Natural vegetation is left on all sides of the fields with vegetative strips in between fields to protect from soil and water erosion. We plant a variety of crops from mid-April to mid-June every two weeks to take advantage of the available soil moisture. Hopi farmers use our own heritage varieties of seeds and plant by hand with the occasional use of a tractor and a modified one row planter. Crops are planted counter to stream flow and wind direction. Corn is planted three paces or 2.7 meters apart using 10 to 20 seeds in a single hole. Our corn which we have developed over many generations can be planted at depths from 15.2 to 45.7 centimeters. Our planting depth depends on the location of moist soil below the surface. The corn is thinned out at least three times leaving four to six plants to harvest. Wide spacing and frequent thinning is done to preserve soil moisture because we receive no rainfall from April to late July. After harvest, corn stalks are left on the fields as planting guides for the next season's crop, which are planted in between last year's rows. Corn stalks act as natural snow catchments, which concentrates much needed moisture during spring

planting and remaining corn stalks deter winds in the spring time which protect emerging corn seedlings.

Figure B2: Windbreak constructed from natural vegetation to prevent water and soil erosion and create snow drifts to add more moisture to the soil in areas where planted.



The underlying philosophical foundation or “land ethic” used by Hopi farmers is tied directly to their belief system. For example, the corn (maize) harvested is given to the women who go through the corn carefully, selecting the ears that will be used to plant the following years and for the Hopi baby naming ceremony. Corn is often ground by the women to make *Homa* (Hopi prayer meal). There is no separation between spirituality and agriculture at Hopi because the land and the Hopi need each other to survive. As a result, we tend to and view our fields as we do the natural world with great reverence and respect. “...*the Hopi perceive the earth as their mother, the one from whom they were born and receive their sustenance, and to whom they will return after death* (Loftin 1991

p.9).” As a result of our philosophical approach, great care is taken to have a minimal impact on the environment.

The way we manage natural resources in our fields ties directly back to our belief system. We are not owners of the land we plant, but stewards. Great care is taken to not make our fields too big to prevent soil and subsequent moisture loss from spring windstorms that generate wind gusts up to 13.6 to 104.6 kilometers per hour. It is our underlying philosophy to not take more than we need and use only what nature gives us. For example, the earth provides us vegetation to erect wind breaks and stones to construct check dams to slow down the flow of water during monsoon events. Our agricultural techniques are designed to preserve soil moisture. Water is a precious natural element at Hopi. Every Hopi song and prayer are dedicated to providing rain and snowfall to our fields. It sustains us, because water is life. Therefore, our philosophical approach to natural resource management is holistic and engages all things necessary to keep our way of life in balance.

3.2. The La Courte Band of Chippewa Wild-Rice Agriculture

The La Courte Band of Chippewa, are members of the Lake Superior Chippewa Indians, or Ojibwe. They inhabit 19,424 hectares of land consisting of 4,046 hectares of lakes, as well as 321.9 kilometers of streams (Tiller 2015). The La Courte Band, like their fellow counterparts, have been harvesting and maintaining traditional wild-rice beds for sustenance, as well as commercial ventures. Wild rice has been found in archeological sites that date back to about 2400 BP and was recovered in an early woodland burial site in Michigan (Rajnovich 1984).

Harvesting of wild-rice is done by women and men who travel in flat bottom boats to wild-rice fields so as not to disturb the rooting structures of the wild-rice plants. Once the participants arrive at their destination, they bind the wild-rice plumes tightly to make sure the rice will become mature enough to harvest. The binding process creates clear pathways that act as channels for the navigation of other tribal members who also harvest using boats. During harvest, the wild-rice plant is not removed as is commonly done by non-Indigenous peoples who use machines that cut the whole plant. The Ojibwe leave the plant intact and harvest the rice after it matures by using a technique called "knocking." Knocking involves thrashing the bound wild-rice plumes, which knocks the wild-rice seeds into the boat. Complete stands of wild-rice are left intact making sure that some of the wild-rice seeds will fully mature and then drop and scatter and produce new wild-rice stands the following growing season. Not all wild-rice plants are harvested; only those that are deemed ready have their wild-rice plumes bound. The Ojibwe also manage their wild-rice beds by clearing obstructions that may block streams from flowing in and out of the lakes where wild-rice is grown (Venum 1998). This provides the nutrients necessary for continued wild-rice growth and creates habitats for aquatic insects preyed upon by fish.

The Ojibwe word for wild-rice is *manoomin*, and it is not just a staple-food for the Ojibwe people. Like the maize of the Hopi, it is prevalent in their ceremonies and stories (Venum 1998). All things associated with *manoomin*, including its harvesting and where it is raised, is viewed as sacred. Based on the intimate philosophical relationship Ojibwe have with wild-rice, the environment around it is managed in a way that takes care of *manoomin* and preserves all the spiritual and physical benefits she brings (Venum

1998). This is a holistic management approach based on the underlying Ojibwe philosophy that all things are connected, and by helping manage wild-rice, or rather nurturing *manoomin*, Ojibwe, such as the La Courte Band of Chippewa, also believe they are nurturing themselves (Vennum 1998).

3.3. Menominee Forestry Agriculture

The Menominee are the longest continuous residents of present-day Wisconsin. According to Tiller (2015), the Menominee resided in the region for at least 10,000 years. The total area of their reservation is 95,125.2 hectares (Tiller 2015). Their land consists of forests, and the Menominee have been managing forests in some aspect before their original treaty with the United States in 1853 (Trosper 2007).

The Menominee use a "high rotation age" meaning they do not harvest trees for commercial use until they reach 200 years or more, rather than the standard USDA forestry practice of 80-100 years. They also use the process of "selection harvest" or uneven aged management to increase and support biodiversity by maintaining stands of trees that include multiple age groups. Low intensity fires are often used as a way of managing forest undergrowth. The tribe also prefers to have a large and diverse growing stock on the same land unit rather than harvesting then reseeding with the same tree species. The tribe also uses long term monitoring of the forest. The Menominee foresters use community management principles in which their forest management goals take precedent over industrial goals.

Although forest management of the Menominee is viewed as an economic venture by the tribe, their approaches to sustaining the forest are based on their own cultural land

ethic. The Menominee philosophical approach to forest management is described in the following passage:

“[The land ethic] has always contained the three elements of a sustainable system. First he [the forest] must be sustainable for future generations. Second the forest must be cared for properly to provide for the needs of the people. And third, we keep all the pieces of the forest to maintain diversity (Davis 2000 p. 4).”

For example, Jostad et al. (2008 p. 576) interviewed one of the tribal land managers and he indicated, “The forest is part of our culture, is a source of spiritual renewal, and is the foundation of our economic well-being.” As a result, the Menominee have been credited with developing approaches to sustained yields in forest management. Maintaining a balance of the entire forest ecosystem and critical wild life habitat is at the forefront of Menominee forest decision-making.

Menominee philosophical approaches to natural resource management are holistic, grounded in their own belief system, and demonstrated through practicing stewardship rather than ownership of the forest. Like the Hopi, they do not take more than they need, and the number of trees harvested is not dependent on economic gain. There is no standard USF harvesting formula used to determine forest sustainability (Trospen 2007). The Menominee harvesting formula is based on their culture and needs to sustain their culture. Menominee forests are resilient and sustainable because management aspects of stewardship directly correlate to maintain a rich biodiverse forest

in that all things have equal spiritual value. No one species of tree can survive without the other nor is one species of plant more important than the other.

4. Discussion

Indigenous societies across the globe have been practicing placed-based conservation for millennia (Berkes 1999; Cruikshank 2005; Nasady 2003; Nelson 1983; Menzies 2006; Pierotti 2011; Trospen 2009). Indigenous people have been managing forests, grasslands, waterways, and natural fisheries and domesticating plants, such as maize, beans, and squash for millennia and continue to pass that knowledge from generation to generation (Menzies 2006; Pierotti 2011). They have developed a variety of conservation management techniques based on a deep ecological understanding of their environment. Their holistic approach to conservation management runs counterintuitive to western approaches to natural resource management which tend to commodify nature for economic gain (Fuentes-George 2013; Osborne & Shapiro-Garza 2018).

We demonstrate in our case studies that Indigenous agricultural systems employed by Hopi dryland farmers, the La Courte Band of Chippewa wild-rice harvesters, and Menominee tribe foresters achieve results similar to NRCS standard practices. The Indigenous practices outlined in our case studies demonstrate the reliance on holistic conservation management schemes reflecting deep cultural values embodied in time-tested practices and Indigenous concepts of stewardship, rather than the commodification of the natural world. The holistic approach to Indigenous conservation management schemes integrates a belief system based on the tribe(s) oral traditions often relating to their own concept of how they were created and how they were to survive. As a result, Indigenous conservation management schemes that include various types of

agriculture have been practiced and have contributed to a sustainable way of life. The philosophical approaches of Indigenous people are best understood by looking at the similarities in outcomes between IAK and NRCS conservation practices and at the differences in their approaches to the same environmental problems.

4.1. IAK Time Tested v. NRCS Scientifically Validated

Although, tribes like the Hopi, La Courte Band of Chippewa and the Menominee do not have their Indigenous Agricultural Knowledge and subsequent management techniques scientifically validated, there can be no doubt they are time-tested and philosophically based on each tribes' individual cultural belief system. IAK practices, as demonstrated by Hopi farmers, go back at least 2000 years (Hough 1897; Stewart 1940) and the wild-rice harvesting practiced by the Ojibwe go back 10,000 years (Rajnovich 1984). The Menominee tribe's forest management practices are relatively recent, starting some 100 years ago, but are still valued by agencies such as the USFS as being sustainable because of the uniqueness of the harvesting techniques that they developed. The question poised here to the reader is eloquently stated by an Ethiopian farmer:

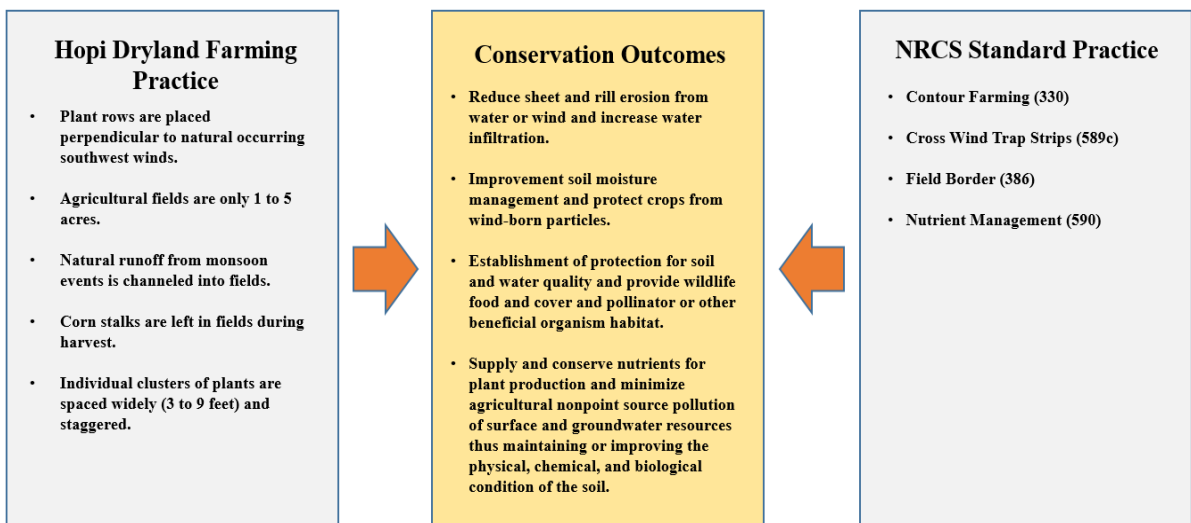
“The beliefs and practices that define us as a Indigenous peoples are often called ‘informal knowledge’ I must ask what makes the so-called ‘formal knowledge’ of scientists and academics more valuable?” (Utto Tange Wondimu 2015)

NRCS use 219 standard conservation practices for both cost-share incentive programs; EQIP and CSP. NRCS conservation techniques have been scientifically

validated but only for a relatively short period (75 years) compared to IAK techniques. NRCS conservation history shows that conservation practices initially were implemented because of the American “Dust Bowl” that occurred in the 1930’s. NRCS practices were developed because the prior utilization of the land led to vast amounts of soil loss due to overgrazing and harmful agricultural implements such as the mold board plow.

1. *Hopi Dryland Agriculture*: Our study found there are at least 23 Hopi traditional agricultural conservation techniques similar to NRCS conventional agricultural techniques contained in the national NRCS *Field Office Technical Guide* (FOTG). Hopi dry-farming practices and NRCS standard practices have similar outcomes but are applied differently (See Figure B3).

Figure B3: A comparative analysis of outcomes from Hopi dryland farming practices and NRCS standard practices.



A comparison of techniques and outcomes between NRCS and Hopi conservation techniques can be done with the application of “Cross wind trap strips” (See Figure B4). The primary purpose of the practice is to reduce soil erosion from wind and increase snow deposits in the fields to preserve and add soil moisture. Hopi farmers have been

using this technique for centuries. Hopi farmers leave natural vegetative strips to slow down prevailing winds in the spring and also act as snow buffers to trap snowfall on the field preserving much needed moisture necessary to germinate seeds in the spring. IAK knowledge of Hopi farmers dictates the use of pre-existing natural vegetation for their applications, whereas NRCS conventional conservation management practices uses mechanization to seed non-native plants.

Figure B4: Cross wind trap strips for Hopi fields on the left and NRCS conventional agricultural practices on the right. Practices designed to prevent wind and soil erosion.

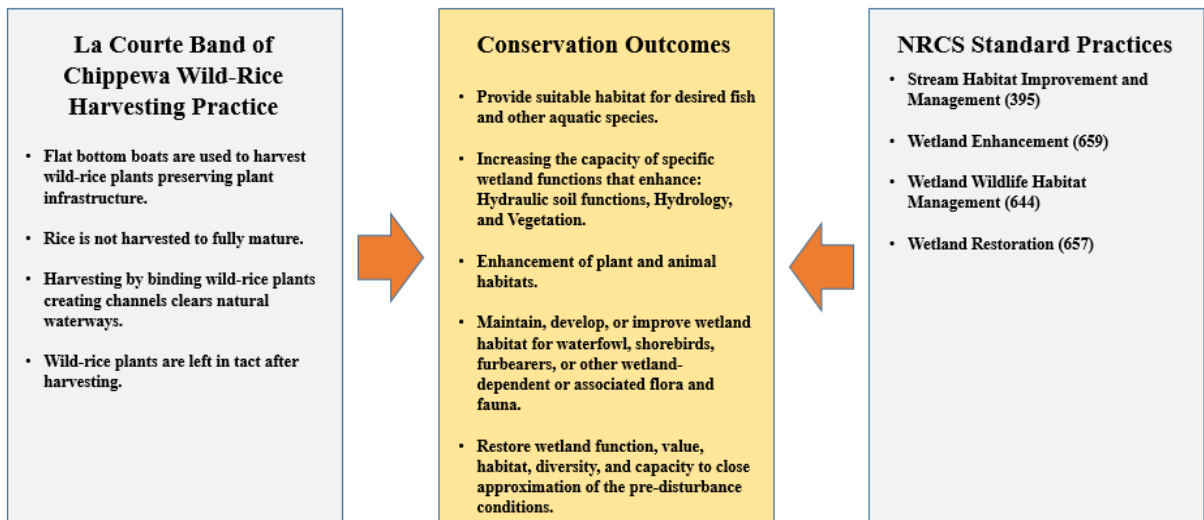


Another example is the conservation practice of “Field borders,” which are used to reduce wind and water erosion, protect soil and water quality and provide wildlife food and cover. Again, the NRCS treatment is applied after the field has been established. The cost associated with conventional application of the treatment is again associated with mechanization and the purchase of herbaceous cover crops. Hopi farmers carve out their fields leaving natural vegetative structures intact. This is of no cost to the Hopi producer and suppresses soil loss from spring wind storms. Natural vegetation is used on the fields as small brush wind barriers on Hopi bean, melon and squash plants. The landscape left

around Hopi planting areas is left undisturbed, thus preserving the natural environmental conditions and foods such as rice grass left to feed the wildlife population.

2. *La Courte Band of Chippewa Wild Rice Harvesting*: NRCS provides practices for wetland conservation in designated riparian areas (NRCS 2018). Some of the NRCS standard practices include; Stream Habitat Improvement and Management, Wetland Enhancement, Wetland Wildlife Habitat Management, and Wetland Restoration (Figure B5). These practices provide suitable habitats for desired fish and other aquatic species. It further provides stream channels and associated riparian conditions that maintain stream corridor ecological processes and hydrological connections of diverse stream habitat types important to aquatic species.

Figure B5: A comparative analysis of outcomes of La Courte Band of Chippewa wild rice harvesting practices and NRCS standard wetland conservation practices.



The outcomes of La Courte Band of Chippewa wild-rice harvesting practices and NRCS standard practices are similar, as we demonstrate in Figure B5. However, the practices from a management perspective are different. For example, the channels created by the La Courte Band of Chippewa are not predetermined as in the case of NRCS

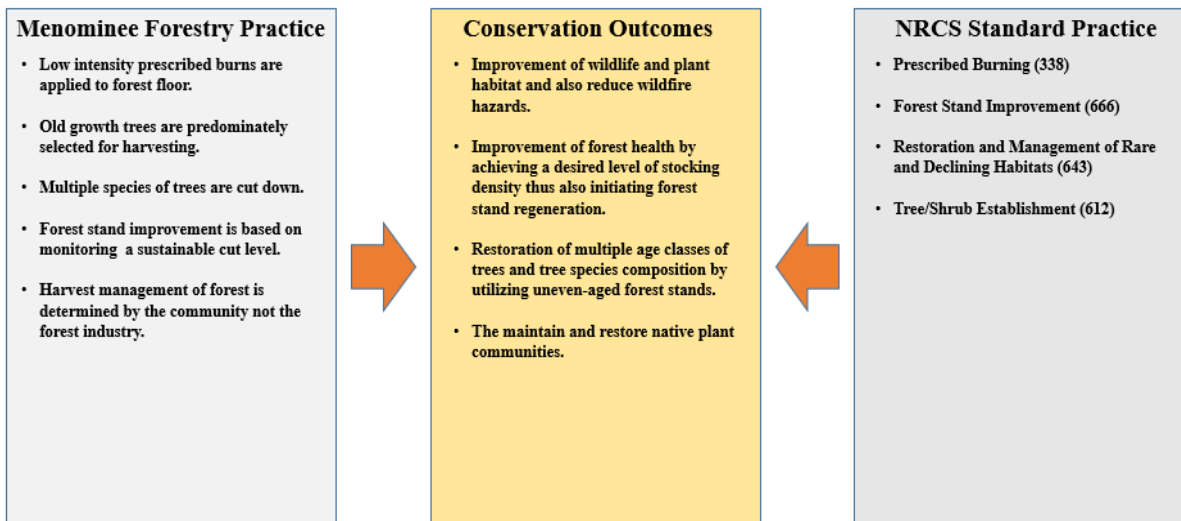
standard practices. The channels are simply cleared because of the harvesting process, which does not lead to environmental degradation, but rather improves aquatic conditions.

3. Menominee Forestry Management: We demonstrate the Menominee concepts of forestry management have similar outcomes to NRCS forest management techniques by comparing NRCS standard practices to Menominee forestry management initiatives (Figure B6). The Menominee case study demonstrates how the tribe uses USF practices to supplement their own IAK based on their philosophical belief system to be true forest stewards. Economic viability is not at the forefront of Menominee forestry management as dictated by the forestry industry, but rather the well-being of the community is at the center of the decision-making process (Trosper 2007).

NRCS (2018) has a variety of standard practices relating to forestry. For example, the NRCS standard practice that is similar to those forestry management techniques practiced by the Menominee foresters is Forest Stand Improvement. Some of the purposes include but are not limited to; 1) Increasing the quantity and quality of forest products by manipulating stand density and structure and 2) Reducing the potential damage from wildfire. The Menominee practice “Increasing the quantity and quality of forest products by manipulating stand density and structure through a process called *Section Harvest* (Trosper 2007). Section Harvest is used in place of “clear cutting” and only the older trees are harvested for use. The Menominee also use traditional methods of Prescribed Burns to reduce damages from wildfires (Brown 2009). Also, “Fire stimulated the understory from a biodiversity standpoint which is probably positive for plant and

animal interactions, providing more browse and more flowers for pollinators and insects (Brown 2009 p. 4).”

Figure B6: Outcomes/goals associated with the philosophical approaches of Menominee foresters and NRCS standard practices.



Few scientific studies have been initiated to better understand Indigenous natural resource management and the placed-based unique cropping systems where Indigenous people reside. However, the environmental benefits are strongly implied by the time depth associated with Indigenous holistic management practices. It is clear that TEK and its subsidiary IAK offer alternative solutions to some of the environmental degradation caused by linear approaches to solving conservation problems (Berkes 1999; Cruikshank 2005; Menzies 2006; Nasady 2003; Nelson 1983; Pierotti 2011; Trospen 2009).

4.2. IAK Stewardship v. NRCS Commodification

The concept of stewardship is nothing new to Indigenous people in the United States, as well as across the globe. Tribal existence depended on how land was managed. Often times, as in the cases that we present, Indigenous land management initiatives were

looked at as a “way of life.” In other words, Indigenous people felt they are were part of the process and valued the resources in their totality. As a result, IAK is a framework for sustainable subsistence that is not entirely compatible with the markets of commodification. The tools and nutritional supplements of Indigenous agricultural fields and harvesting practices (wild-rice and forests) were gleaned directly from the place-based contexts. For example, the practice of “Nutrient Management” as labeled by NRCS involves the application of soil supplements by use of mechanization and fertilizing (N, P, K). Nutrients that are managed in relationship to the “Hopi way of Knowing” are placed on the fields by natural runoff from rain events that bring nutrient rich stream flows into Hopi fields.

The La Courte Band of Chippewa wild-rice harvesters provide another example of how stewardship approaches provide greater benefits than a commodity-based approach. A study by Oelke et al. (1982), in association with the University of Minnesota’s Agriculture Extension Service, looked at mechanization approaches to the harvesting of wild-rice, as well as full scale production of wild-rice. They found conventional agricultural harvesting methods caused heavy losses of wild-rice stands due to disease and insect predation. The loss of natural rice stands also was correlated with the loss of fish and wildlife habitats. The loss of habitats for certain species of fish and wildlife does not occur with the time-tested practices of Ojibwe wild-rice harvesting methods, rather habitat and rice stands are enhanced.

The Menominee case is unique because the foresters of the tribe make the decisions of when it is time to harvest and what is harvested. They have a holistic natural resource management approach based on philosophical cultural beliefs, as do the other

two case studies. Economics do not govern the Menominee forestry harvesting process but rather their belief system. The philosophical uniqueness of IAK is not found in the natural resource management schemes governed by NRCS conservation practices. The holistic philosophical approach of Hopi farmers to conservation management may be summarized in the following statement by author Johnson:

“I was taught as a young boy to respect all things. When I would travel with my grandfather to look for a specific plant we would eventually find it, but we did not pick the first one we came to. I was told to leave it, so the plant could continue to grow because it would provide seed for next year. So we left it and gathered the next one. It was not about the outcome of gathering plants and even how much we harvest after our agricultural season is over, but it is all about the journey. A journey to leave something for the next generation something better.”

NRCS linear approaches to solving natural resource concerns are limited. It is limited because each standard practice found in the NRCS *Field Office Technical Guide* is viewed as a practice and not as a teaching or oral tradition, which have stood the test of time. We found in our studies of the philosophical approaches to conservation management, the true journey of conservation management is not only the preservation of the land but also ourselves.

NRCS in contrast, and the agency’s commitment to “helping people help the land” is in stark contrast to IAK philosophical concepts. For example, NRCS standard

practices are piecemeal in their approach to addressing a natural resource concern as compared to looking at the concern in its totality and its overall effect of environmental degradation. All the tribes discussed in our paper have a “land ethic” that predates “The Land Ethic” as described in Aldo Leopold’s (1949) *A Sand County Almanac* by over 10,000 years. The central idea to the comprehensiveness of American Indian natural resource management is based upon what was previously described as the “Native American Land Ethic, (Jostad and McAvoy 1996 pp. 565-566). The authors stress two fundamental reasons behind the Native American Land Ethic (NALE) that should be followed:

- 1) A clearer understanding of the Native American land ethic is necessary because federal and state agency resources managers are increasingly required to work with tribal members and managers in regarding tribal natural resources and governmental natural resources in and close to reservations.

- 2) More understanding is needed because the Native American land ethic may provide guidance or a model that can be considered as this country seeks to incorporate a more holistic approach in resource policy development and decision making at the state and federal levels.”

5. Conclusions

NRCS policy is based on the agencies commitment to “Helping People Help the Land.” However, from an Indigenous perspective, the NRCS commitment of “Helping

People Help the Land” might better be understood as “Letting the Land Help the People.”

This philosophical approach to conservation management used by Indigenous people may be framed from the following viewpoint:

The Story of the Mountain

Given the task of climbing a mountain, there are two approaches, linear and holistic. For the linear approach, as is often done in our dominant Euro-American culture, the objective is placed firmly in sight and the procedure is to attain the goal as quickly as possible. Thus, if the goal is to climb to the top of a mountain, the quickest, easiest way is to lay a ladder down from the bottom to the top and proceed up the rungs one at a time to reach the top. Using that analogy, our Euro-American then looks around for a few minutes at the top of the mountain and then proceeds to the next goal, the next task.

On the other hand, the Native (Indigenous) approach is somewhat different. Starting at the bottom of the mountain, at the bottom of the ladder, if you will, the Native notices a tree off to the side and decides to go explore it. From there he sees a lake farther around the side of the mountain. He decides to get a drink and maybe swim for a while. From the lake, he sees something else to explore, and so on around and around and gradually up the mountain.

The difference in these approaches is that the Euro-American got to the top quicker but the Native understands the mountain. It is more important to accomplish things quickly or is it more important to fully understand the task, the accomplishments and the implications of what we are doing?

Dr. Robert Rhodes,
Personnel Communication, October 20, 2018

Our paper demonstrates Indigenous agricultural practices/techniques have similar outcomes to NRCS standard practices located in the NRCS *Field Office Technical Guide* (FOTG). We did this by comparing and contrasting the best-practices of three tribes. Nevertheless, NRCS standard practices are still broken down into categories based on their desired effect. Attention must now be placed on the holistic natural resource management criteria as developed by the three tribes previously mentioned. NRCS, in

their attempt to achieve their goal, provides cost-share programs, such as the Environmental Quality Incentives Program (EQIP) and Conservation Stewardship Program (CSP). Both programs are incentive based and further lead down the economic road of commodifying nature by offering a variety of conservation techniques found in the NRCS Field Office Technical Guide.

The underlying philosophies for all three tribes in their approaches to natural resource management is not found in the commodification of nature (Bermejo Gomez de Segura 2014; Mrozowki 1999) or in terms of assigning numerical value as is the case with private property. Rather, the philosophical approach is based on Indigenous “ways of knowing” and the concept of stewardship and connections between the land and the people (Berkes 1999). The principles of holistic natural resource management initiatives are inherent in Indigenous natural resource management even in today’s market economy-based world. To fully integrate Indigenous agriculturalists into NRCS cost-share programs, their holistic natural resource management practices must be recognized and supported by the funding structure. Finally, implementation of EQIP or CSP contracts on Indigenous lands must embrace the integrated nature of Indigenous conservation practice and incorporate the full value of the tribes’ cultural ties to the land so as to not separate them from the way they view their relationship with the land.

References

- Abel, K., & Friesen, J. (1991). *Aboriginal resource use in Canada historical and legal aspects* (Canadian electronic library. Books collection). Winnipeg [Man.]: University of Manitoba Press.
- Berkes, F. (1999). *Sacred ecology: Traditional ecological knowledge and resource management*. Philadelphia, PA: Taylor & Francis.
- Bermejo, R. (2014). The Commodification of Nature and Its Consequences. In *Handbook for a Sustainable Economy* (pp. 19–33). Springer.
- Brown, M. (2009). Low-intensity Fire in Eastern White Pine A Supporting Role in Understory Diversity.
- Bureau, U. S. C. (2018). American FactFinder. Retrieved November 25, 2018, from <https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml?#>.
- Cruikshank, J. (2005). Do glaciers listen? local knowledge, colonial encounters and social imagination (Brenda and David McLean Canadian studies series). Vancouver, B.C.: UBC Press.
- Davis, T. (2000). *Sustaining the Forest, the People, and the Spirit*. State University of New York Press, Albany.
- Dominguez, S., & Kolm, K. E. (2005). Beyond Water Harvesting: A Soil Hydrology Perspective on Traditional Southwestern Agricultural Technology. *American Antiquity*, 70(4), 732–765. <https://doi.org/10.2307/40035872>.
- Fuentes-George, K. (2013). Neoliberalism, Environmental Justice, and the Convention on Biological Diversity: How Problematizing the Commodification of Nature Affects Regime Effectiveness. *Global Environmental Politics*, 13(4), 144–163. https://doi.org/10.1162/GLEP_a_00202.
- Hamilton, B. (2018). Personnel Communication.
- Hough, W. (1897). The Hopi in relation to their plant environment. *American Anthropologist*, 10(2), 33–47.
- Johnson, M. K., Lien, A. M., Sherman, N. R., & López-Hoffman, L. (2018). Barriers to PES programs in Indigenous communities: A lesson in land tenure insecurity from the Hopi Indian reservation. *Ecosystem Services*, 32, 62–69. <https://doi.org/10.1016/j.ecoser.2018.05.009>.

- Jostad, P. M., McAvoy, L. H., & McDonald, D. (1996). Native American land ethics: Implications for natural resource management. *Society & Natural Resources*, 9(6), 565–581. <https://doi.org/10.1080/08941929609380996>.
- Leonetti, C. (2010). Indigenous Stewardship Methods and NRCS Conservation Practices Guidebook. Retrieved November 25, 2018, from https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1045245.pdf.
- Leopold, A. (1970). A Sand County almanac: With essays on conservation from Round River (1st Ballantine Books ed.). New York: Ballantine Books.
- Loftin, J., Ebrary, Inc, & NetLibrary, Inc. (2003). Religion and Hopi life (2nd ed., Religion in North America). Bloomington: Indiana University Press.
- Marshall Pecore; Menominee Sustained-Yield Management, *Journal of Forestry*, Volume 90, Issue 7, 1 July 1992, Pages 12–16, <https://doi.org/10.1093/jof/90.7.12>.
- Mausbach, M. J., & Dedrick, A. R. (2004). The length we go: Measuring environmental benefits of conservation practices. *Journal of Soil and Water Conservation*, 59(5), 96A–103A.
- Menzies, C. R. (2006). Traditional ecological knowledge and natural resource management. University of Nebraska Press.
- Mrozowski, S. A. (1999). Colonization and the commodification of nature. *International Journal of Historical Archaeology*, 3(3), 153–166.
- Nadasdy, P. (2003). Hunters and bureaucrats power, knowledge, and aboriginal-state relations in the southwest Yukon. Vancouver, B.C.: UBC Press.
- National Park Service Working with American Indians, Alaska Natives And Native Hawaiians. (2018). Retrieved November 26, 2018, from <https://www.nps.gov/history/tribes/>.
- Natural Resource Conservation Service. (2017). Environmental Quality Incentives Program. Available at: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/financial/eqip/?cid=nrcs144p2_068634, accessed October 1, 2018.
- Nelson, R. (1983). Make prayers to the raven: A Koyukon view of the northern forest. Chicago: University of Chicago Press.
- Oelke, E. A., Grava, J., Noetzel, D., Barron, D., Percich, J., Schertz, C., ... Stucker, R. (1982). Wild rice production in Minnesota.

- Osborne, T., & Shapiro-Garza, E. (2018). Embedding Carbon Markets: Complicating Commodification of Ecosystem Services in Mexico's Forests. *Annals of the American Association of Geographers*, 108(1), 88–105.
<https://doi.org/10.1080/24694452.2017.1343657>.
- Pierotti, R., & ProQuest. (2010). Indigenous knowledge, ecology, and evolutionary biology (Indigenous peoples and politics). New York: Routledge.
- Rajnovich, G. (1985). A Study of Possible Prehistoric Wild Rice Gathering on Lake of the Woods, Ontario. *North American Archaeologist*, 5(3), 197–215
<https://doi.org/10.2190/AK95-MGD4-NYDY-KG2U>.
- Rhodes, R. (2108). Personnel Communication.
- Salmón, Enrique. (2012). Eating the Landscape: American Indian Stories of Food, Identity, and Resilience (First Peoples: New Directions in Indigenous Studies). Tucson, AZ: U of Arizona P.
- Singletary, L., Emm, S., Loma'omvaya, M., Clark, J., Livingstone, M., Johnson, M.K., & Oden, R. (2015). Hopi People of the Land: Sustainable Agriculture on the Hopi Reservation, University of Nevada Cooperative Extension.
<https://www.unce.unr.edu/publications/files/ag/2014/cm1402.pdf>.
- Stewart, G. R. (1940). Conservation in Pueblo agriculture: II. Present-day flood water irrigation. *The Scientific Monthly*, 51(4), 329–340.
- Tannura, M. A. (2007). *Weather, Corn and Soybean Yields and Technology in the US Corn Belt* (PhD Thesis). University of Illinois at Urbana-Champaign.
- Thompson, L., Joseph, A., University of Chicago. Committee on Human Development, & United States. Bureau of Indian Affairs. (1965). The Hopi way. New York: Russell & Russell.
- Tiller, V. (2015). Tiller's guide to Indian country: Economic profiles of American Indian reservations (Third ed.).
- Trosper, R. L. (2007). Indigenous influence on forest management on the Menominee Indian Reservation. *Forest Ecology and Management*, 249(1–2), 134–139.
<https://doi.org/10.1016/j.foreco.2007.04.037>.
- Trosper, R., & ProQuest. (2009). Resilience, reciprocity and ecological economics Northwest Coast sustainability (Routledge studies in ecological economics; 3). London; New York: Routledge.
- U.S. Forest Service Tribal Relations. (2018). Retrieved November 26, 2018, from
<https://www.fs.fed.us/spf/tribalrelations/>.

Vennum, T. (1988). Wild rice and the Ojibway people. St. Paul: Minnesota Historical Society Press.

Waters, Fredericks, & Fredericks, Oswald White Bear. (1977). Book of the Hopi. Harmondsworth, England; New York: Penguin Books.

Wunder, S. (2005), Payments for environmental services: some nuts and bolts. Occasional Paper. No. 42., *CIFOR*.

APPENDIX C: THE EXPANSION OF NATURAL RESOURCE CONSERVATION
SERVICE COST-SHARE PROGRAMS ON AMERICAN INDIAN RESERVATIONS

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The Expansion of Natural Resource Conservation Service Cost-Share Programs on American Indian Reservations

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ABSTRACT

American Indian farmers and ranchers face barriers that hinder their access to United States Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) cost-share programs. Prior studies indicate that two of the barriers American Indians face are lack of capital and limited federal recognition of time-tested Indigenous Agriculture Knowledge based methods. The NRCS has undertaken several steps to rectify these problems, such as the 2010 *Indigenous Stewardship Methods and NRCS Conservation Practices* guidebook, but by the FY of 2017, there were still only 1,035 NRCS cost-share contracts awarded to American Indian producers out of 49,140 awarded across the country. Here we summarize the barriers, review current available solutions, and offer further policy recommendations to address the problem of limited American Indian participation in NRCS programs. Our policy goal is to expand NRCS cost-share programs on the 99 million acres in Indian Country held in trust by the federal government. This expansion will support American Indian farmers and ranchers with economic opportunities and help preserve time-tested agricultural conservation techniques. Creating better access to United States Department of Agriculture (USDA) conservation programs for American Indian farmers and ranchers not only will be economically and culturally beneficial to American Indian people, but will also help NRCS meet its mission of “*Helping People Help the Land.*”

Keywords: Natural Resource Conservation Service, Cost-Share Programs, Indigenous Agricultural Knowledge

1. Introduction

On American Indian reservations, lack of capital and limited federal recognition of time-tested Indigenous Agricultural Knowledge (IAK) and techniques hinder the participation of American Indian farmers and ranchers in United States Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) cost-share programs (Johnson et al., 2018; Johnson et al., 2019). IAK is “applied knowledge for raising food and other agricultural products that is grounded in Indigenous belief systems and practices which have been time-tested over millennia” (Johnson et al., 2019 p. 4). In the FY of 2017 there were only 1,035 Environmental Quality Incentive Program (EQIP) and Conservation Security Program (CSP) cost-share contracts awarded to American Indian producers out of a total of 49,140 contracts awarded nationally (Hamilton, 2018). EQIP and the CSP are NRCS’s lead programs for providing technical and financial assistance to landowners to address natural resources concerns (NRCS, 2017; CSP, 2019). As a result of limited American Indian participation in these programs, the federal government is missing opportunities to support conservation practices on the 99 million acres in Indian Country. Furthermore, American Indians are missing opportunities to increase economic revenue and expand food production using time-tested Indigenous agricultural techniques. Here we review the barriers to participation faced by American Indian producers and propose policy solutions for the expansion of NRCS cost-share programs in Indian Country.

2. Problems and Barriers

The lack of capital is a serious challenge to successful implementation of NRCS cost-share contract programs in Indian Country because of the socio-economic conditions

American Indian participants face on reservation lands (Johnson et al., 2018 and Tiller, 2015). This is a barrier because USDA programs require participants to share project costs. The cost-share rate is the percentage of the total contract cost born by the participant. NRCS's standard cost-share rate is 75%, making the participant's financial obligation 25%. NRCS state conservationists have the flexibility to raise the cost-share rate for socio-disadvantaged producers, such as American Indians, from the standard 75% to 90%. For example, if a \$100,000 project is approved, then NRCS will provide \$90,000 and \$10,000 will be the responsibility of the participant.

In addition, NRCS programs provide an advanced payment of 50% for project costs (Bramblett, Personnel Communication, 2019). Advance payments are "*cash payments made by a Federal entity to its employees, contractors, grantees, or others as partial or full payments of the costs of goods, services, or easements the entity has not yet acquired*" (NRCS 2018 p. 414-B.3). An advance payment can be used to purchase materials needed to implement the NRCS project, such as labor, equipment, and materials. For example, if the total cost of materials, labor and equipment is \$50,000, then a NRCS advance payment would cover \$25,000 of those items. Advance payments are only issued after the applicant obtains an NRCS approved practice design. However, due to the socio-economic conditions found on most reservations, most American Indian producers and tribal governments do not have the means to pay the remaining 50% of up-front costs (Tiller, 2015). As a result of the lack of financial capital to fully implement the project, EQIP contracts in Indian Country often fall into non-compliance and are cancelled (Johnson, et al., 2018).

Second, the fact that IAK-based practices are not readily accepted by the NRCS presents an additional barrier to American Indian participation in NRCS programs. In order to participate in EQIP or CSP, an applicant must agree to employ one or more of the 219 standard conservation practices outlined in the NRCS's *Field Office Technical Guide* (FOTG). Most of these practices do not reflect Indigenous ways of conserving and managing the land. According to the NRCS guidebook, *Indigenous Stewardship Methods and NRCS Conservation Practices*, many producers in Indian Country see NRCS standard practices as untested and poorly suited to their environment, and would prefer to use IAK methods (Leonotti, 2010).

To address these concerns, the NRCS developed the aforementioned guidebook which outlined a method for validating IAK-based methods in order to include them in the FOTG (Leonotti, 2010). According to the guidelines, each IAK practitioner must individually petition their local NRCS District Conservationist for permission to use IAK methods on their contracted project. The process requires the land owner to provide written justification that their proposed techniques address the resource concern and will lead to similar outcomes as NRCS standard practices. For the individual applicant, the process for obtaining authorization for IAK practices presents an additional bureaucratic hurdle in what, as noted above, is already a challenging application process for American Indians (Johnson et al., 2019). Overall, the net result of this approach has been an *ad hoc* process where IAK practices are justified on a case-by-case basis rather than through a systemic process that relies on the synergistic expertise of IAK practitioners across the nation.

The NRCS has made efforts to include Indigenous producers in their cost-share programs, but lack of capital and limited recognition of time-tested Indigenous agricultural techniques are still barriers to participation in Indian Country. Solutions must specifically target those barriers to increase American Indian producer involvement in NRCS cost-share programs.

3. Policy Solutions

3.1. Lack of Capital

To address the barrier caused by the lack of capital, two factors must be considered: cost share rates and advance payments. Currently, the NRCS does not provide state conservationists flexibility in setting advance payment rates. Fifty-percent is often not enough for those tribal governments whose budgets are spread thin to provide more immediate pressing needs associated with socio-economic circumstances (Tiller, 2015). We recommend that state conservationists be given the same flexibility in setting advance payment rates on a case-by-case basis as they have for cost share rates. This would require Congressional action and expanded NRCS budget. Our solution would bring financial relief to tribal governments by providing the necessary financial capital to successfully complete an NRCS contract. A change in the advanced payment rate would allow NRCS projects to be implemented more quickly because tribal governments would then have the financial ability to cover the anticipated material costs of the project.

Another approach to address issues relating to lack of capital is the more wide-spread use of a new mechanism found in the 2018 Farm Bill, Title II, Section 2503(c)-*Administrative requirements for conservation programs*. This mechanism requires the USDA to enter into Alternative Funding Arrangements (AFA) with socio-disadvantaged

farmers—USDA considers American Indian participants to be socio-disadvantaged (Tiller, 2015). This instrument first appeared in the 2008 Farm Bill and was strengthened when the implementation language was changed from “*may*” to “*shall*” in the 2018 Farm Bill. The AFA mechanism requires USDA funds to be disbursed directly to a tribe if the tribe submits a conservation planning proposal to NRCS (Colby, Personnel Communication, 2019). The tribes can then administer the funds for their own conservation programs without oversight from the Bureau of Indian Affairs (Colby, Personnel Communication, 2019). The AFA mechanism could also lessen the burden of land tenure insecurity by reducing bureaucratic barriers and supporting tribal self-governance. While the mechanism still requires NRCS approval of conservation practices, it opens the possibility for IAK practices because tribes are now in charge of determining how the funding can be used.

3.2. Indigenous Field Office Technical Guides

To address the difficulty in approving IAK methods, we propose the development of Indigenous Field Office Technical Guides (IFOTG) as an alternative to the standard national NRCS FOTG. We envision that IAK methods in IFOTGs will be acceptable as NRCS standard practices for obtaining NRCS cost-share contracts. The development of federal agency sponsored IFOTGs will recognize the fact that IAK conservation methods have been time-tested for over millennia; and as such, are legitimized by their rigor, replicability, and conservation outcomes (Nicholas, G. 2018; Johnson, et al., 2019).

We are proposing pilot projects for two or three American Indian tribes in different regions of the country to explore potential formats for IFOTGs to be implemented regionally or tribally. The use of multiple locations for initial meetings

would ensure widespread inclusion of tribal members not just associated with one tribe but also other tribes, because tribal agricultural management schemes differ widely depending on their location (Ritchie, et al., 2013). We will also clearly identify stakeholders needed in the formation of the IFOTGs. Some of the questions that need to be addressed are; Should the IFOTGs be tribally based or regionally based? How will issues be dealt with related to tribal intellectual property, such as the IAK methods used and genetic material derived from the products produced? What stakeholders (e.g. tribal elders, NRCS officials, etc.) should participate in the IFOTGs review process?

We recommend a community-based participatory research (CBPR) process involving IAK holders, which include elders and active participants in their communities and locally-based American Indian non-profits to develop the IFOTGs (Atalay, 2012; Kovach, 2009). A series of initial meetings would take place to see if a tribe wants to participate and be conducted using tribal research protocol including issuance of a tribal research permit. Once we establish which tribes wish to be part of the pilot project, criteria will be established to determine which IAK methods the participants would like to be recognized by NRCS. CBPR should not just be used in gathering data, but also should contain the *“inclusive creation of knowledge and the interactions of this knowledge with social values...”* (Colloff et al., 2017 p. 1008). To increase collaboration, American Indian producers and tribal elders should decide what IAK methods they would like included in the IFOTG with advice from the NRCS officials on how to implement their requests (Beier et al., 2017; Meadow et al., 2015).

The objective of the IFOTGs is to increase American Indian engagement in agriculture and improve access to USDA programs. The creation of IFOTGs will

circumvent the ponderous procedure of including IAK methods in the NRCS FOTG outlined in the 2010 NRCS guidebook. The IFOTGs will help streamline tribal access to the AFA's. In addition, IFTOGs will reinforce tribal cultural identity and counter the lack of inclusion experienced by IAK practitioners, such as Hopi farmers who view NRCS standard practices as not well suited to their environment. Finally, IFOTGs will provide IAK practitioners equal access to NRCS cost-share program's as their non-Indian counterparts.

4. Conclusions

We have outlined potential solutions to the two barriers identified: lack of capital and lack of federal recognition of time-tested Indigenous agricultural techniques. The goals of the policies outlined in this paper are to increase the expansion of NRCS cost-share programs on American Indian reservations.

The lack of capital continues to be a barrier for the implementation of NRCS programs in Indian Country that may be addressed through calling for greater use of the AFA and/or increasing the advance payment rate to 90%. The USDA is required under the 2018 Farm Bill to seek out Alternative Funding Arrangements with tribes for EQIP and CSP. Increasing advance payment rates should not be overly costly to USDA, because most IAK practices are place-based and use materials found in the environment (Johnson, et al., 2019). However, financial support is still needed to develop the IFOTGs, document IAK methods, and hold participatory meetings.

IAK methods are based upon a holistic and philosophical understanding of the environment and represent more than a millennia of time-tested applied conservation methods (Berkes, 1999; Johnson et al., 2019). They should be encouraged by the USDA

and NRCS. Our proposal to develop IFOTGs reinforces tribal IAK methods and their American Indian “Ways of Knowing” in the area of agricultural conservation.

We live in a world where climate change is occurring. These events are having a negative effect on our environment. IAK and their methods/techniques, developed over millennia to help American Indians confront extreme environmental conditions, may someday help the broader community of agricultural producers in the US adapt to extreme conditions using cost-effective and environmentally beneficial approaches (Johnson, et al., 2019). The conservations methods promoted by the NRCS should address a broader goal than the NRCS’s stated mission of “Helping People Help the Land.” Moving forward, the NRCS should also recognize the Indigenous philosophy and time-tested approach of “Letting the Land Help the People (Johnson et al., 2019).”

References

- Agricultural Conservation: USDA's Environmental Quality Incentives Program Could Be Improved To Optimize Benefits. (2017). Washington, D.C.: General Accounting Office.
- American Farm Bureau Federation. (2019). Reviewing the 2018 Farm Bill Baseline. Available at: <https://www.fb.org/market-intel/reviewing-the-2018-farm-bill-baseline>, accessed January 25, 2019.
- Atalay, S., & Ebrary, Inc. (2012). Community-based archaeology research with, by, and for indigenous and local communities. Berkeley: University of California Press.
- Barsh, R. (2001). Who Steals Indigenous Knowledge? *Proceedings of the ASIL Annual Meeting*, 95, 153-161. doi:10.1017/S0272503700056834.
- Beier, P., Hansen, L. J., Helbrecht, L., & Behar, D. (2017). A How-to Guide for Coproduction of Actionable Science: Coproducing actionable science. *Conservation Letters*, 10(3), 288–296. <https://doi.org/10.1111/conl.12300>.
- Bramblett, J. (2019). Personnel Communication.
- Brewer, J. P., Hiller, J. G., Burke, S., & Teegerstrom, T. (2016). A Primer: Extension, Indian Land Tenure, and Rangeland Limitations. *Rangelands*, 38(1), 16–22. <https://doi.org/10.1016/j.rala.2015.12.002>.
- Broegaard, R. J. (2005). Land tenure insecurity and inequality in Nicaragua. *Development and Change*, 36(5), 845–864.
- Bureau, U. S. C. (2018). American FactFinder. Available at: <https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml?#>, accessed November 25, 2018.
- Calloway, D. H., Giauque, R. D., & Costa, F. M. (1974). The superior mineral content of some American Indian foods in comparison to federally donated counterpart commodities. *Ecology of Food and Nutrition*, 3(3), 203–211. <https://doi.org/10.1080/03670244.1974.9990382>.
- Cochran, P. A., Marshall, C. A., Garcia-Downing, C., Kendall, E., Cook, D., McCubbin, L., & Gover, R. M. S. (2008). Indigenous ways of knowing: Implications for participatory research and community. *American Journal of Public Health*, 98(1), 22–27.
- Colby, D. (2019). Personnel Communication.
- Colloff, M. J., Lavorel, S., van Kerkhoff, L. E., Wyborn, C. A., Fazey, I., Gorddard, R.,

- Degeorges, P. (2017). Transforming conservation science and practice for a postnormal world: Conservation for a Postnormal World. *Conservation Biology*, 31(5), 1008–1017. <https://doi.org/10.1111/cobi.12912>.
- Conservation Stewardship Program. (2019). Natural Resource Conservation Service. Available at: <https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/csp/>, accessed January 25, 2019.
- Daw, T., Brown, K., Rosendo, S., & Pomeroy, R. (2011). Applying the ecosystem services concept to poverty alleviation: the need to disaggregate human well-being. *Environmental Conservation*, 38(4), 370–379. <https://doi.org/10.1017/S0376892911000506>.
- Dasgupta, P. (2001). *Human well-being and the natural environment*. Oxford: Oxford University Press.
- NASA Earth Observatory. (2018). Drought Persists in the U.S. Southwest. (2018). Available at: <https://earthobservatory.nasa.gov/images/144216/drought-persists-in-the-us-southwest>, accessed January 28, 2019.
- Flows, C. (2014). 5 Ways The Government Keeps Native Americans In Poverty. Retrieved January 16, 2019, from <https://www.forbes.com/sites/realspin/2014/03/13/5-ways-the-government-keeps-native-americans-in-poverty/>.
- Hamilton, B. (2018). Personnel Communication.
- Johnson, M. K., Lien, A. M., Sherman, N. R., & López-Hoffman, L. (2018). Barriers to PES programs in Indigenous communities: A lesson in land tenure insecurity from the Hopi Indian reservation. *Ecosystem Services*, 32, 62–69. <https://doi.org/10.1016/j.ecoser.2018.05.009>.
- Johnson, M.K., Rowe, M.J., Lien, A.M., López-Hoffman, L. (2019). Examining compatibility and conflicts in the integration of Indigenous Agriculture Knowledge into National Resource Conservation Service cost-share initiatives. [White paper] Retrieved January 16, 2019, from Udall Center for Studies in Public Policy: <http://udallcenter.arizona.edu/publications-resources/publications/indigenous-nations-policy>.
- King, S. R., Carlson, T. J., & Moran, K. (1996). Biological diversity, indigenous knowledge, drug discovery and intellectual property rights: creating reciprocity and maintaining relationships. *Journal of Ethnopharmacology*, 51(1–3), 45–57.
- Kovach, M. (2009). Indigenous methodologies: Characteristics, conversations and contexts (Canadian Electronic Library. Canadian publishers collection).

- Leonetti, C. (2010). Indigenous Stewardship Methods and NRCS Conservation Practices Guidbook. Available at: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1045245.pdf , accessed January 28, 2019.
- Levitan, S & Hetrick, B. (1971). Big Brother's Indian programs, with reservations. New York: McGraw-Hill.
- Meadow, A. M., Ferguson, D. B., Guido, Z., Horangic, A., Owen, G., & Wall, T. (2015). Moving toward the Deliberate Coproduction of Climate Science Knowledge. *Weather, Climate, and Society*, 7(2), 179–191. <https://doi.org/10.1175/WCAS-D-14-00050.1>.
- National Centers for Environmental Information (2018). Drought - State of the Climate. Available at: <https://www.ncdc.noaa.gov/sotc/drought/201802>, accessed, accessed March 27, 2018.
- National Sustainable Agriculture Coalition. (2018). 2018 Farm Bill by the Numbers. Available at: <http://sustainableagriculture.net/blog/2018-farm-bill-by-the-numbers/>, accessed January 25, 2019.
- Natural Resource Conservation Service. (2017). Environmental Quality Incentives Program. Available at: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/financial/eqip/?cid=nrcs144p2_068634, accessed August 27, 2017.
- Natural Resource Conservation Service General Manual State Supplements and Amendments (2018), NRCS Washington. Retrieved March 22, 2019, from https://www.nrcs.usda.gov/wps/portal/nrcs/detail/wa/people/employees/?cid=nrcs144p2_036378.
- Nelson, R. (1983). Make prayers to the raven: A Koyukon view of the northern forest. Chicago: University of Chicago Press.
- Nicholas, G. (2018) It's taken thousands of years, but Western science is finally catching up to Traditional Knowledge. Retrieved March 13, 2019, from <https://theconversation.com/its-taken-thousands-of-years-but-western-science-is-finally-catching-up-to-traditional-knowledge-90291>.
- Ritchie, S. D., Jo Wabano, M., Beardy, J., Curran, J., Orkin, A., VanderBurgh, D., & Young, N. L. (2013). Community-based participatory research with Indigenous communities: The proximity paradox. *Health & Place*, 24, 183–189. <https://doi.org/10.1016/j.healthplace.2013.09.008>.
- Tiller, V. (2015). Tiller's guide to Indian country: Economic profiles of American Indian reservations (Third ed.).

U.S. Department of Indian Affairs. (2019). Division of Natural Resources. Available at: Nearly 200 horses found dead amid Southwest drought in Arizona. (n.d.). Retrieved March 11, 2019, from <https://www.cbsnews.com/news/horses-found-dead-southwest-drought-arizona-najavo-nation/>
<https://www.bia.gov/bia/ots/division-natural-resources>, Accessed February 8, 2019.

APPENDIX D: THE RESILIENCY OF HOPI AGRICULTURE: 2000 YEARS OF
PLANTING

Johnson, M.K. and Falk, L. (2018) The resiliency of Hopi agriculture: 2000 years of planting. Arizona State Museum, Tucson, AZ.

The Resiliency of Hopi Agriculture: 2000 Years of Planting

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1. The Purpose of the Exhibit

My exhibit at the Arizona State Museum, *The Resiliency of Hopi Agriculture: 2000 Years of Planting*, demonstrates the Hopi traits of resiliency and ingenuity, and the continuity of Hopi agricultural practices on the Little Colorado Plateau in northern Arizona. As a member of the Hopi tribe, and as an active farmer on the Hopi reservation, I have several reasons for creating and promoting an exhibit on Hopi agriculture.

First, I want to demonstrate and document that the Hopi way of farming, which has existed for over 2000 years, has remained virtually unchanged. We manage our fields and crops—consisting of corns, beans, melons, and squash—using the same techniques as our ancestors. The exhibit presents the continuity of Hopi farming practices through side-by-side photographs showing Hopi crops of the present day and the same crops planted more than 100 years ago. I also want to show that what we do as Hopi farmers is our “way of life,” reflective of larger Hopi society and that consists of constant agricultural challenges, such as drought, wind, and predation from insects, crows, and rabbits. The exhibit includes photographs that prominently show these challenges. The exhibit also portrays how all members of Hopi society have a role in agriculture, including the children. Farming is not just about Hopi men planting, tending, and harvesting their fields. It is also about the role of women (who actually own the fields) and children. This leads to my next motivation for the exhibit.

I aspire to encourage Hopi youth to understand and recognize that many of the challenges they face, both in their fields as well as life itself, can often be overcome by understanding and incorporating knowledge that has been passed down from generation to generation by Hopi people. As I have been told, and is stated in the exhibit: “We were

farmers before we had ceremonies”—meaning that planting is the major tenet of Hopi life that the ceremonies celebrate.

The exhibit also shows that we raise and tend crops in an extreme, semi-arid landscape. I use a quote in the exhibit that contrasts Hopi agricultural approaches to that of Western, more conventional agriculture: “We plant corn to fit the environment we come from and [do] not try to manipulate the environment to fit the corn.” Farming is the very essence of who we are. In many respects it defines us as a people as well as the environment we come from. Farming for my Hopi people is an “act of faith.”

Another aim for my exhibit is to educate the public about the importance of Hopi agriculture and our “way of life.” I want to show that Hopi people are still here and practicing a way of life that has sustained us for thousands of years, and that our way of agriculture is not based on economics, per se, but rather adheres to our spiritual beliefs and our covenant to be stewards of the land we reside in. The broader message to the public is that agriculture does not have to be commodified with a set price on what is produced. Rather, agriculture from a Hopi perspective is used to teach morals and values such as responsibility, reciprocity, and the importance of hard work. There is no separation between Hopi agriculture and Hopi spirituality; they both depend on each other. As Hopi people, we cannot have one without the other.

Finally, I hope to begin the process of protecting what we have as it relates to our intellectual property. Protecting our intellectual property has to do with our seeds and traditional knowledge learned over the past 2000 years. Documenting our material resources and practices lays claim to our intellectual property rights. The exhibit demonstrates some of the best-practices of Hopi farmers.

2. Feedback

The Resiliency of Hopi Agriculture: 2000 Years of Planting exhibit opened April 14, 2018 and will run through June 19, 2019. At the opening, I made a presentation about the exhibit and what I hoped it would accomplish. Initial feedback from those who viewed the exhibit has been positive. There always seems to be amazement that we as Hopi farmers could grow things like corn, melons, and squash in a semi-arid region without irrigation. One audience member commented that the Western system of conventional agriculture could gain a lot of insight on how we conserve water and the techniques we use. Another exhibit viewer told me that she could see clearly how the management of Hopi agriculture has changed little over time. She noted the evidence presented in the photographs that demonstrated the continuity of crops like corn and beans over the span of a more than a century.

3. Challenges in the Exhibit

One of my biggest challenges in opening such an exhibit was the question of how much information about Hopi agriculture, practices, and society should be included. Hopi agriculture, as practiced by our elders, is a central tenet of our spirituality and defines who we are as a people. For example, crops that are raised by Hopi farmers are used in ceremonies, such as white corn that is made into prayer meal called “homa.” Gourds grown by Hopi farmers are made into rattles. The cultural significance of crops raised, and items produced is held privately and confidentially within the Hopi community. Our agricultural techniques are often kept secret and they vary from farmer to farmer in what techniques work best for the area where Hopi fields are located. On the other hand, many

of the techniques we use to raise crops in our semi-arid environment have been documented, and photographed, in various scholarly journals.

Part of the exhibit preparation process involved obtaining the permission of the Hopi Cultural Preservation Office (HCPO) and the Cultural Resource Advisory Task Team (CRATT). At the meeting with CRATT, I was asked to explain my exhibit to the team. CRATT consists mainly of Hopi farmers, most of whom are elders and have expertise and traditional knowledge about Hopi agriculture. Several matters of concern came out of that meeting.

The first concerned some of the early indicators we observe to gauge available soil moisture. For example, in the approval letter I received after the meeting, I was asked not to name certain plants that were displayed in an exhibit photograph. In this case, CRATT was concerned that the Hopi knowledge contained in some of the photographs could be used by other tribes who would then claim the knowledge presented in the exhibit.

Although not directly related to the content of the exhibit, a second concern was raised about the protection of our heirloom seeds and cross-contamination with genetically modified organisms (GMO) crops such as corn. One member made mention of the fact that preserving our Hopi seeds was of utmost importance. Not only do our seeds produce crops to feed people, but they also create products used in different Hopi ceremonies. The importance of maintaining the biodiversity of crops helps Hopi farmers overcome natural challenges such as drought and insect predation. For example, seeds from a very dry year are saved and then planted in years that have similar environmental conditions.

Finally, on a personnel level, I was challenged internally by a member who felt that the exhibit was based on self-interest. He said to farm as we do must require a great deal of humility. He also made mention of the fact that I had brought CRATT a finished product without consulting them from the beginning. The question that arose in my mind at that time was, “Is the exhibit really worth doing if it pulled at the core of who I was, and my ability to share and communicate the importance of these issues.” This was personally very challenging. I continued because I contend a lot of our societal problems derive from western influences, such as the forced adoption of a western form of government, introduction of cattle into our agricultural landscape, and the placement of more value on material things that have slowly eroded our Hopi “way of life.” The way out of our societal challenges, I argue, is through the revitalization of Hopi agriculture and all the different “ways of knowing” and Hopi values and morals it brings with it.

Similar challenges arose when working with the Museum curators. For example, some debate took place on whether or not to use Hopi words for the crops presented. As with other languages, there are several dialects of Hopi, and by using a Hopi dictionary, which was written in the dialect of “Third Mesa”, issues of which word is correct can arise. In the end, we decided not to use Hopi words that were uncommon across dialects. Another issue was trying to find a vocabulary the general public could understand without taking the value away from what Hopi farmers do. This was addressed by attempting to hint at the underlying cultural significance of Hopi agriculture but staying away from the spiritual aspects of what is displayed. For example, at the beginning of the exhibit, a case displays a Hopi planting stick, gourd, and corn. A brief explanation was

provided using a quote from a published source describing those items and their cultural significance without going into detail about their spiritual properties.

The final challenge I faced was how to accurately display Hopi ingenuity, resiliency and continuity without feeling I was doing an injustice to my Hopi community. The exhibit was a balancing act for me internally by showing the public the importance of what we do as a Hopi society without sacrificing the society itself and opening it up for intrusive future research, such as has been done in the past.

4. Next Steps

The exhibit was built to travel, but at this time I do not know where it will go when the display ends at the Arizona State Museum in June 19, 2019. For me, the exhibit is the first step in engaging public interest and gaining support to create a new generation of Hopi farmers by raising awareness of Hopi farming and its importance to Hopi people in an attempt to lay the foundation for:

1. Establishing an educational outreach and resource center for the Hopi community, as well as to serve as an outside research entity specifically designed to provide research opportunities to address the issues around Hopi agricultural management.
2. Providing incentives for Hopi youth to become farmers and giving them the necessary tools, skills, and financial resources to do so.
3. Establishing a tribal farm to raise traditional Hopi crops with seeds going directly back to the community for the establishment of new Hopi fields and for the revitalization of existing, but now abandoned, fields.

4. Developing policies at the federal, tribal, and even international level for
 - (a) protection of Hopi heirloom crops, (b) improved access to USDA's Natural Resource Conservation Service (NRCS) programs (like the Environmental Quality Incentives Program (EQIP) and the Conservation Stewardship Program (CSP)), and (c) designation of Hopi as Globally Important Agricultural Heritage System (GIAHS) site.

5. Reflection

The exhibit is a combination of photographs taken at my families' fields from 2005-2017 with those collected from various archives housed in museums. Producing the display took a lot of effort and communication between me and those involved in the project, including various administrators at the Arizona State Museum, and the hiring of a graphic designer who could maintain the right scope of the project. The result of all these efforts is a beautiful display of Hopi resiliency, ingenuity, and continuity defining the practices and importance of Hopi agriculture. I am optimistic that with this foundation laid, the next steps will come into fruition to help preserve Hopi well-being and to provide a valuable lesson for American society as a whole.

For More Information:

The Resiliency of Hopi Agriculture: 2000 Years of Planting-Exhibit Video-
<https://www.youtube.com/watch?v=28gAFESNGMU&t=52s>

Crops Rising from a Cracked Desert-National Geographic Blog
<https://blog.nationalgeographic.org/2017/05/01/crops-rising-from-a-cracked-desert/>

Thoughts of a Hopi Farmer- <https://www.youtube.com/watch?v=wJ-tLq7yhk4>

Hopi People of the Land: Sustaining Agriculture on the Hopi Reservation-
<https://www.unce.unr.edu/publications/files/ag/2014/cm1402.pdf>