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## Advancing healthy and sustainable food environments: The Flathead Reservation case study

**SELENA AHMED,**

Food and Health Lab, Montana State University

**CARMEN BYKER SHANKS,**

Food and Health Lab, Montana State University

**VIRGIL DUPUIS,**

Salish Kootenai College

**MIKE PIERRE**

Flathead Food Distribution Program on Indian Reservations

### Abstract

This case study describes a methodological approach to evaluating and improving food environments in an indigenous community in the United States of America. A community-research partnership was developed to support healthy diets from sustainable food systems. Our team implemented complementary methodologies to evaluate multiple dimensions of the food environment, including food availability, convenience, affordability and desirability. Our findings were used to design and implement multiphase food-environment interventions that elucidated the following: (1) food-environment measurements should be multifaceted and context-specific; (2) food desirability, including sensory attributes, diversity and phytonutrient quality, are important but overlooked aspects of the food environment; (3) successful food-environment interventions are community-based and incremental; (4) food-environment interventions should seek to forge links with existing institutional structures to influence policy; and (5) findings from food-environment interventions should be disseminated in various ways to diverse stakeholders.

### INTRODUCTION

Nestled in the Mission Mountain Range of the Rocky Mountains in the United States of America, amid forests, valleys and rivers, is the Flathead Reservation. It is the home to Montana's Bitterroot Salish, Kootenai and Pend d'Oreilles tribes. Historically, these indigenous peoples relied on the wild foods of their surroundings by hunting, fishing and gathering (Figure 1). The colonization of tribal lands resulted in a dramatic shift from wild food environments (Ahmed and Herforth, 2017) to built ones, comprised largely of processed foods high in refined sugars, saturated fats and salt (Byker Shanks et al., 2016). The transition from place-based food systems to processed foods has been linked to the

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Contact the authors at: [foodandhealthlab@gmail.com](mailto:foodandhealthlab@gmail.com).

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nutrition transition, with notable implications for health (Kuhnlein and Receveur, 1996; Popkin, 2001).

Food environments are the consumer interface of the food system that influence the availability, affordability, convenience and desirability of food (Herforth and Ahmed, 2015). The concept of the food environment has evolved over the past 15 years to recognize the complex socio-ecological determinants of diets (Story et al., 2008; Herforth et al., 2017b). Numerous studies have highlighted disparities in food environments among indigenous, rural and other minority communities (Story et al., 2008; Lutfiyya et al., 2012). Despite goals to eliminate health disparities and food insecurity, minority groups report unequal rates of food insecurity and diet-related chronic disease compared with the overall population (Blue Bird Jernigan et al., 2017; Satia et al., 2005; Rabbitt et al., 2016). In the United States of America, one in four Native Americans is food insecure, double the national average (Blue Bird Jernigan et al., 2017).

The Food Distribution Program on Indian Reservations (FDPIR) emerged in 1973 as a federal assistance programme to address food security challenges in Native American communities in the United States of America. Through the FDPIR, low-income residents living on and near Native American reservations receive a monthly supply of foods. While the FDPIR has become critical for supporting local food security, it offers a very different food environment to the historical food environments of Native American communities. Canned, powdered and dried foods greatly outnumber fresh foods, with few or no local foods.

In response to the food and nutrition challenges experienced in Native American communities, we have fostered a community partnership over the past six years to evaluate and improve food environments on the Flathead Reservation. Our team comprises practitioners, researchers, food and nutrition stakeholders, policy-makers and student trainees from the Flathead Reservation, along with researcher partners from The Food and Health Lab at Montana State University. The overall goal of our project is to inform tribal and national food programmes, along with local enterprises, to improve access to foods that support sustainable diets that are affordable, convenient and desirable. Sustainable diets are defined as healthy diets from sustainable food systems that advance the human condition and conserve ecological resources in socially acceptable ways (Ahmed and Byker Shanks, 2019).

In this article, we share our community-based approach to examining and modifying food environments on the Flathead Reservation. First, we review research methodologies to evaluate the food environment, coupled with household surveys on perceptions of the food environment, food security and dietary quality. Next, we describe how we applied our food-environment and household surveys to design and implement community-based interventions to enhance food environments that support sustainable diets. We conclude by sharing lessons learned, with a view to advancing food environments through an evidence-based approach.

## MULTIFACETED FOOD-ENVIRONMENT MEASUREMENTS

Multiple complementary research methods are needed to evaluate the multifaceted dimensions of the food environment. While over 500 food-environment research methods exist, the majority use geographic analysis and observational tools to evaluate food availability and affordability (Herforth and Ahmed, 2015). There remains a need to evaluate the desirability aspect of the food environment in ways that are cross-culturally relevant (Herforth and Ahmed, 2015; Herforth et al., 2017a). Desirability of the food environment involves external factors, including marketing, product placement, social norms and food quality, that influence individual preferences and food choices (Ahmed et al., 2018). The need for measuring food desirability is especially important, as food preferences are a key component of international food security definitions (FAO, 2002; World Food Summit, 1996).

Our team developed and validated three methods to evaluate desirability of fruits and vegetables, which can be applied in diverse contexts, including the Produce Desirability (ProDes) sensory evaluation survey (Ahmed et al., 2018), the Produce Color Diversity (ProColor) inventory tool and total phenolic scores of produce (Ahmed and Byker Shanks, 2017). We focused on the desirability of fruits and vegetables, in recognition that dietary recommendations for produce consumption are not achieved across populations (Haack and Byker, 2014), particularly in minority communities in the United States of America (Lutfiyya et al., 2012), while the daily consumption of produce is associated with supporting nutrition and health (United States Department of Health and Human Services and USDA, 2015).

Table 1 describes the measurements we used to evaluate food availability, affordability and desirability. It also highlights results from our food-environment assessments and points to notable disparities in built food environments on the Flathead Reservation compared with more urban surrounding food environments. Evaluation of the FDIPIR food environment using the Healthy Eating Index (HEI) found that the average total HEI score for five randomly selected food packages was 66 compared with the maximum HEI score of 100 for the diet recommended by national dietary guidelines (Byker Shanks et al., 2016). HEI results showed limited availability of nutrient-dense foods, including fresh fruits, vegetables, protein and whole grains (Byker Shanks et al., 2016).

As described in Table 1, while the Nutrition Environment Measurement Survey for Stores (NEMS-S), ProDes and total phenolic scores found disparities in produce desirability on the Flathead Reservation compared with more urban surrounding areas (Byker Shanks et al., 2015b; Ahmed et al., 2018; Ahmed and Byker Shanks, 2017), no significant differences were found in terms of produce availability and affordability. Concurrently, the Farmers' Market Audit Tool found little discrepancy based on location (Byker Shanks et al., 2015a). However, there are cultural barriers within the community to visiting farmers markets.

We found the implementation of NEMS-S to provide a useful benchmark of commonly consumed foods in the United States of America for comparative purposes, yet to be limited in its application to place-based food systems. The ProDes and ProColor methods were

useful in their adaptability to local food systems in evaluating culturally relevant produce from wild and natural food environments in a simple, cost-effective, reliable and rapid way. Overall, the various food-environment assessments have proved complementary in nature. In particular, our study highlights the importance of measuring the desirability dimension of food environments; just because specific foods may be available and affordable, this does not mean they are desirable, with notable consequences for food choices.

## **HOUSEHOLD SURVEYS ON FOOD-ENVIRONMENT PERCEPTIONS, FOOD SECURITY AND DIETARY QUALITY**

We carried out baseline household surveys on the Flathead Reservation to better understand how food environments may impact diets and health. Table 1 describes these household assessments and findings, including surveys on food-environment perceptions, wild foods, food security, dietary quality – measured using the HEI and Dietary Diversity Scores (DDS) – and perceptions of health. Since our food-environment assessments did not evaluate convenience, we examined perceptions of convenience using surveys. As described in Table 1, survey findings reflect the disparities found in food-environment assessments and the need to enhance food environments on the Flathead Reservation.

## **EVIDENCE-BASED AND MULTIPHASE FOOD-ENVIRONMENT INTERVENTIONS**

We applied findings from our multiple assessments, along with a community needs assessment to design culturally appropriate interventions to improve access to foods that support sustainable diets on the Flathead Reservation. The community needs assessment was carried out with our project's Community Advisory Board of food and nutrition stakeholders, comprising elders, educators, enterprise representatives, clinical practitioners and policy-makers, including a member of the Tribal Council. Each year, we incrementally enhance the intervention and its assessment based on reflection and stakeholder feedback.

In 2016, we implemented the Eat Fresh intervention with 20 low-income households participating in the FDPIR over a two-month period. This intervention was aimed at eliminating access barriers to affordable fresh and desirable produce through food and nutrition education, culinary training and the provision of fresh fruits and vegetables. We evaluated the effectiveness of the intervention using self-reported surveys on food choices, dietary quality and perceptions of health, along with measurements of blood pressure, weight and body mass index.

Multiple participants experienced improvements in various self-reported health parameters during the intervention, including overall perceived well-being, mood, optimism, mental alertness and energy. Findings demonstrate a trend of increased dietary quality based on the HEI between the pre-intervention and post-intervention periods. Significant improvement was found in fruit consumption across the intervention. However, overall food consumption for some participants increased with the promotion of fruit and vegetable consumption and resulted in increased weight gain. This unintended consequence of promoting fruit and

vegetable consumption elucidated the importance of focusing on produce consumption in the context of whole diets.

In 2017, we implemented the Eat Fresh and Local intervention, with 40 households participating in the FDPIR over a three-month period. The initiative involved modification of the FDPIR on the Flathead Reservation to include fresh local produce, as well as to provide food and nutrition education and culinary training. The local produce was sourced from the Western Montana Growers Cooperative, a food hub that sources from surrounding farms that follow various sustainable agricultural practices.

We refined the food and nutrition curriculum of the previous intervention to focus on whole diets, including portion control, as well as the benefits of foods sourced from local sustainable agricultural systems. We added haemoglobin A1c as an intervention measure. Findings from the intervention highlighted notable variability in participants' interactions with the modified food environment of the FDPIR and resulting diets. Dietary quality and health outcomes improved for some participants but stayed the same for others. In addition, findings highlighted the high level of participant interest in consuming foods from local sustainable agricultural systems. In 2018, we implemented the Healthy & Sustainable Diets for All intervention, with 40 households participating in the FDPIR and other food-assistance programmes over a four-month period. This intervention provided produce, whole grains and pulses sourced from local sustainable agricultural systems to participants, along with education on sustainable diets (Ahmed and Byker Shanks, forthcoming).

We integrated social-media modalities to target and broaden the scope of our nutrition education (Tobey and Manore, 2014). The sustainable-diets curriculum focused on the following topics: (1) sustainability, (2) biodiversity and dietary diversity, (3) indigenous food systems, (4) plant-based foods, (5) food security and sovereignty, (6) greenhouse gas emissions, (7) food waste and (8) consumers as agents of food-system change. We are currently analysing data from this intervention phase, which use the same measures as in the previous phase, with the addition of a nutrition knowledge survey. Our upcoming intervention phase for 2019 extends the duration of the intervention and adds mindfulness training with a view to enhancing consumer interaction in food environments.

## LESSONS LEARNED

Our assessments and evidence-based interventions on the Flathead Reservation have produced the following lessons to date towards advancing healthy and sustainable food environments:

1. Food environments are multifaceted and require multiple context-specific measurements to capture distinct yet complementary factors.

The use of various complementary food-environment methods allows for a more comprehensive understanding of the different aspects of food availability, affordability, convenience and desirability.

2. Food desirability is an important, but overlooked measurement of the food environment.

Just because specific foods may be available and affordable in the food environment, this does not mean that they are desirable. It is, thus, important to measure desirability in the food environment. Our project highlights that the ProDes and ProColor methods are effective in evaluating produce desirability in both wild and built food environments in a way that is rapid, cost-effective and valid.

3. Successful food-environment interventions are community-based, incremental and multi-phased.

Our research team is led and informed by members of the local community of the Flathead Reservation to ensure research questions, methods and activities are relevant and valuable to the local context. An iterative process of implementing food-environment interventions allows us to identify unintended consequences and modify activities.

4. Food-environment interventions should be linked with existing institutional structures.

We have sought to improve food environments by partnering with institutional structures on the Flathead Reservation, including the FDPIR and the Western Montana Growers Cooperative. Additionally, we have sought to build local capacity through research training of local students and community members.

5. Findings from food-environment interventions should be disseminated using a multi-pronged strategy to multiple groups of stakeholders.

We actively share findings with diverse stakeholders from community members to various policy platforms, including the Tribal Council on the Flathead Reservation and national FDPIR platform, through scientific papers, policy briefs, school and program curriculums and community-based art.

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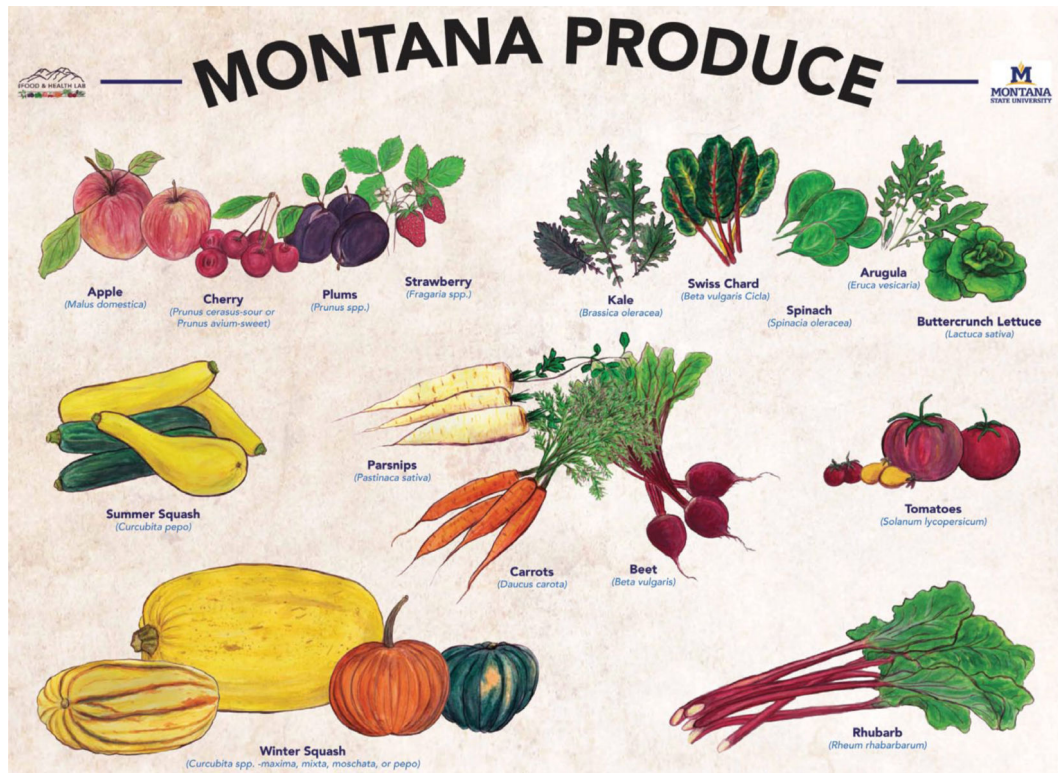
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**Figure 1.**  
WILD FOOD ENVIRONMENTS OF THE BITTERROOT SALISH, KOOTENAI AND  
PEND D'OREILLES TRIBES



**Figure 2.**  
FRUITS AND VEGETABLES PRODUCED IN MONTANA

MULTI-FACETED FOOD-ENVIRONMENT AND HOUSEHOLD-SURVEY MEASUREMENTS WITH FINDINGS ON THE FLATHEAD RESERVATION

Table 1.

Food-environment measurement	Description of food-environment measurement	Findings
<b>Availability:</b> The availability dimension of the food environment focuses on the presence of foods, including those that are healthy, unhealthy, sustainable, local and culturally relevant.		
<b>HEI of food supply</b>	The HEI is a measure of relative dietary quality compared with national dietary guidelines for Americans and can be used to measure both food supply in a given food environment and diets (USDA Food and Nutrition Service, 2019).	<ul style="list-style-type: none"> <li>• Evaluation of the FDIPIR food environment found that the average total HEI score for five randomly selected food packages was 66 compared with the maximum HEI score of 100 for the diet recommended by national dietary guidelines in the United States of America.</li> <li>• Results further show limited availability of adequate amounts of fresh fruits, vegetables, dairy, protein and whole grains - all nutrient-dense foods that mitigate diet-related chronic disease and support sustainable diets (Byker Shanks et al., 2015a).</li> </ul>
<b>Nutrition Environment Measures Survey - Stores (NEMS-S)</b>	NEMS-S is among the most widely used food-environment measurements in the United States of America. It evaluates the built food environment according to availability and affordability of commonly consumed foods, as well as the quality of the 20 most commonly consumed fruits and vegetables (Glanz et al., 2007).	<ul style="list-style-type: none"> <li>• For fruits and vegetables in all 20 study-site stores across Montana, the mean NEMS-S total score was 23.8 and the availability score was 17.1.</li> <li>• NEMS-S total scores and availability scores did not differ by rurality across sites (Byker Shanks et al., 2015a).</li> </ul>
<b>Farmers' Market Audit Tool</b>	The Farmers' Market Audit Tool measures the overall availability of healthy foods at a farmers' market for various categories, including fruits and vegetables, meats, dairy and whole grains (BykerShanks et al., 2015a).	<ul style="list-style-type: none"> <li>• Findings from the Farmers' Market Audit Tool demonstrated little discrepancy based on location in our study, pointing to the valuable role of local seasonal fresh food markets for supporting diets and health (Byker Shanks et al., 2015a).</li> </ul>
<b>Affordability:</b> The affordability dimension of the food environment focuses on the financial resources needed for food procurement, including the costs of healthy, unhealthy, sustainable, local and culturally relevant foods.		
<b>NEMS-S</b>	See above	<ul style="list-style-type: none"> <li>• For fruits and vegetable in all 20 study-site stores across Montana, the mean NEMS-S price score was 2.9.</li> <li>• NEMS-S price scores did not differ by rurality across sites (Byker Shanks et al., 2015a).</li> </ul>
<b>Desirability:</b> The desirability dimension of the food environment focuses on external factors, including marketing, product placement, social norms and food quality, that influence purchase decisions and consumption.		
<b>NEMS-S</b>	See above	<ul style="list-style-type: none"> <li>• NEMS-S scores from grocery stores in our study found that the observational quality of fruits and vegetables was lower in more rural built food environments, including the Flathead Reservation. The mean quality score across sites was 4.5 (BykerShanks et al., 2016).</li> </ul>
<b>Produce Desirability (ProDes) sensory evaluation survey</b>	ProDes assesses the quality aspect of desirability of fruits and vegetables based on generalizable sensory characteristics, including visual appeal, touch and firmness, aroma and size (Ahmed et al., 2018).	<ul style="list-style-type: none"> <li>• Significant differences were found in the means of total ProDes scores based on location.</li> <li>• Produce from more rural built food environments, including locations on the Flathead Reservation, had lower ProDes scores than the urban locations in our study (Ahmed et al., 2018).</li> </ul>
<b>Produce Color Diversity (ProColor) inventory tool</b>	This inventory tool (Ahmed et al., forthcoming) measures the diversity and amount of produce in the food environment based on colour categories in recognition that increased variety of fruits and vegetables is strongly correlated with increased produce consumption (Oude Griep et al., 2011) and that consuming a wide variety of fruits and vegetables is crucial to procure a range of phytonutrients (Liu, 2003), many of which vary in colour (Pennington and Fisher, 2009).	<ul style="list-style-type: none"> <li>• Significant differences were found in the means of total ProColor scores based on location.</li> <li>- Produce from more rural built food environments, including locations on the Flathead Reservation, had lower ProColor scores than the urban locations in our study (Ahmed et al., forthcoming).</li> </ul>
<b>Total phenolic scores of produce</b>	Total phenolic scores are a measure of the quality aspect of food-environment desirability that evaluate phytochemical concentrations of	<ul style="list-style-type: none"> <li>• We found that produce quality, as measured by total phenolic score and vegetable total phenolic score, was lowest for the more rural areas in our survey, while no rurality-based difference was found for fruit total phenolicscores (Ahmed and BykerShanks, 2017).</li> </ul>

	<p>produce linked to health-promoting attributes, flavour, appearance and shelf-life (Ahmed and BykerShanks, 2017).</p>		
<p><b>Household survey</b></p>	<p><b>Description of household survey</b></p>	<p>Semi-structured interviews on perceptions of the built and wild food environment, including foods consumed within the household and community, food access, cultural value of prevalent community foods, and changes in food acquisition and dietary intake at the household and community level over time (Byker Shanks et al., forthcoming).</p>	<p><b>Findings</b></p> <ul style="list-style-type: none"> <li>• While food environments have transitioned to built food environments, and grocery stores provide key food access points, residents continue to rely on wild food environments by hunting, fishing and foraging for wild foods such as fish, deer, elk, bison, berries and roots (Figure 1).</li> <li>• The procurement of wild foods is more prevalent among the older generation.</li> <li>• Produce was perceived as being an uncommon food item available and consumed within the community (Byker Shanks et al., forthcoming).</li> </ul>
<p><b>Food-environment perceptions survey</b></p>	<p>The semi-structured interviews comprised structured and open-ended questions that we developed and validated to characterize the frequency of wild-food procurement, consumption, dietary diversity, valuation, perceptions and observations in the context of climate change (Smith et al., 2019).</p>	<p>US Adult Food Security Survey Module: Six-Item Short Form (USDA Economic Research Service, 2012).</p>	<ul style="list-style-type: none"> <li>• Food-gathering activities in the wild food environment on the Flathead Reservation support food security and cultural identity, while providing a sense of food sovereignty and sensory desirability (Figure 1).</li> <li>• Residents of the Flathead Reservation that rely on wild foods were found to be more food secure, highlighting the critical role of the wild food environment.</li> <li>• Wild food environments are changing globally, including due to factors linked to climate change and shifts in land use and policy.</li> <li>• Residents are concerned about the loss of wild-food knowledge among younger generations (Smith et al., 2019).</li> </ul>
<p><b>Wild foods interviews</b></p>	<p>US Adult Food Security Survey Module: Six-Item Short Form (USDA Economic Research Service, 2012).</p>	<p>The HEI of diets is a measure of relative dietary quality compared with national dietary guidelines for Americans (US Department of Health and Human Services, 2013). The HEI is applied to dietary intake data collected using the multiple-pass 24-hour recall method.</p>	<ul style="list-style-type: none"> <li>• Food-security assessments support disparities in the food environment, with 50 percent of study participants (n=79) reporting low or very low food-security status (Byker Shanks et al., forthcoming).</li> </ul>
<p><b>Food-security scores</b></p>	<p>DDS are calculated using self-reported data from 24-hour dietary recalls, where foods consumed are categorized into unique food groups recognized in many cultures (e.g., vitamin A-rich fruit and vegetables, eggs) and assigned a unique score (FAO, 2012).</p>	<p>We developed and implemented a survey on perceptions of health, asking participants if they perceived changes in their well-being, including: overall well-being, mood, optimism, mental alertness, energy, weight, flatulence, bowel movements, the way clothes fit, and skin. The survey also asked participants if they perceived fruit and vegetable consumption to impact their health, mood, energy levels and mental alertness (Ahmed et al., forthcoming).</p>	<ul style="list-style-type: none"> <li>• We found variability in dietary diversity among community members, with participants that reported higher DDS showing higher intake of dietary fibre, potassium and cholesterol than those with less diverse diets (Byker Shanks et al., forthcoming).</li> </ul>
<p><b>Healthy Eating Index (HEI) of diets</b></p>	<p>We developed and implemented a survey on perceptions of health, asking participants if they perceived changes in their well-being, including: overall well-being, mood, optimism, mental alertness, energy, weight, flatulence, bowel movements, the way clothes fit, and skin. The survey also asked participants if they perceived fruit and vegetable consumption to impact their health, mood, energy levels and mental alertness (Ahmed et al., forthcoming).</p>	<p>At baseline, 45 percent of participants reported their perceived health to be good, 45 percent reported their perceived health to be fair, and 10 percent reported their perceived their health to be poor (Ahmed et al., forthcoming).</p>	
<p><b>Dietary diversity scores (DDS)</b></p>			
<p><b>Survey on perceptions of health</b></p>			