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# Rationale for Optimizing the Nutrition of Agricultural Workers in Uzbekistan Using Specialized Prophylactic Food Products

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**Abstract** Agricultural workers in Uzbekistan face persistent nutritional challenges, including excessive carbohydrate intake and deficiencies in essential micronutrients, which negatively impact their health and productivity. This study evaluated the effects of educational interventions and specialized prophylactic food products (SPFP) on the dietary status of 1,280 agricultural workers in Karakalpakstan. While educational counseling alone failed to improve dietary patterns, the introduction of SPFP based on freeze-dried local fruits and vegetables led to significant improvements in vitamin and mineral intake, particularly vitamins A, C, E, B1, B2, and B6 ($p < 0.05$). The findings highlight the limitations of education-only approaches and underscore the importance of incorporating targeted nutritional supplementation into public health strategies to improve rural health and food security.

**Keywords** Agricultural workers, Nutrition intervention, Specialized food products, Dietary assessment, Micronutrient deficiencies, Uzbekistan

## 1. Introduction

Good nutrition is an essential determinant of health, productivity, and quality of life, particularly for populations engaged in physically demanding agricultural activities. Agricultural workers, who represent approximately 26% of Uzbekistan's labor force, are often at high risk of nutritional disorders due to inadequate dietary practices and persistent nutrient deficiencies [1,2]. Such dietary imbalances typically include an excess intake of carbohydrates, insufficient consumption of dietary fats, especially plant-based, and deficiencies in vital vitamins and minerals, contributing significantly to increased morbidity and decreased labor productivity [3,4].

Research has consistently demonstrated that rural communities face greater nutritional challenges due to limited dietary diversity, socio-economic constraints, and deeply ingrained traditional eating behaviors that are difficult to alter through conventional educational interventions alone [5,6]. Studies conducted in Eastern Europe and Central Asia have similarly highlighted that nutrition-related health problems persist despite informational campaigns aimed at improving dietary practices [7,8].

According to the World Health Organization (WHO) and the Food and Agriculture Organization (FAO), successful strategies for improving nutritional status in vulnerable populations must combine educational initiatives with direct nutritional supplementation or fortification programs. Such combined approaches have consistently shown better results in correcting micronutrient deficiencies and improving overall dietary quality compared to isolated educational interventions [9,10].

In Uzbekistan, these global recommendations have been reinforced by national strategic directives, such as Presidential Decree №UP-36 (February 16, 2024), emphasizing the modernization of agricultural practices, ensuring food security, and promoting the production and consumption of nutrient-dense, environmentally sustainable food products [11]. However, specific nutritional interventions tailored explicitly for the agricultural workforce remain insufficiently explored, underscoring the need for targeted research and evidence-based nutritional strategies.

Considering these factors, the present study was undertaken to evaluate the effectiveness of specialized prophylactic food products (SPFP), developed from locally sourced freeze-dried fruits and vegetables, as a practical nutritional intervention for agricultural workers in Karakalpakstan, Uzbekistan. The

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goal was to scientifically substantiate the use of SPFP as an effective strategy to correct persistent dietary deficiencies and improve the nutritional status of this vital population segment [12].

## 2. Purpose of the Research

The primary purpose of this research was to assess the effectiveness of different strategies for correcting dietary imbalances among agricultural workers in Karakalpakstan, Uzbekistan, specifically focusing on evaluating the impact of educational interventions alone versus educational interventions combined with supplementation using specialized prophylactic food products (SPFP). The study aimed to identify sustainable solutions capable of effectively addressing chronic nutrient deficiencies and improving overall dietary quality, thereby enhancing the health, productivity, and nutritional well-being of agricultural workers.

## 3. Material and Methods

### Study Design and Participants

A cross-sectional and interventional study was conducted involving 1,280 agricultural workers residing in rural regions of the Republic of Karakalpakstan, Uzbekistan. Participants included 550 males (42.9%) and 730 females (57.1%), selected via randomized representative sampling to ensure demographic and regional representativeness. Criteria for exclusion from the study included age below 18 or above 65 years, presence of severe chronic illnesses affecting dietary behaviors (e.g., diabetes mellitus, severe gastrointestinal disorders), and withdrawal or refusal of participation.

**Dietary Assessment Methods.** Two internationally recognized dietary assessment methods were applied:

24-hour dietary recall method: This method was conducted following standardized procedures as recommended by Martinchik et al. (1996) [3]. Participants were trained to recall and record all foods and beverages consumed in the preceding 24 hours, ensuring detailed descriptions of consumed items, portion sizes, and food preparation methods.

Food Frequency Questionnaire (FFQ): To complement the 24-hour recall, participants completed a structured FFQ designed to capture the frequency and portion sizes of commonly consumed food items over the past month, thereby reflecting usual dietary patterns.

### Nutritional Analysis

The nutritional adequacy and compliance of the diets were thoroughly assessed against the established national dietary guidelines as stipulated in SanPiN Uzbekistan №0347-17 (2017) [8], complemented by internationally recognized micronutrient reference intakes specified in the joint FAO/WHO consultative guidelines [12]. An extensive nutritional evaluation encompassed an analysis of 1,800 individual daily dietary records, meticulously examining 26 critical nutritional parameters. The parameters evaluated encompassed both macronutrients and micronutrients in comprehensive detail.

Among macronutrients, particular attention was directed toward assessing total protein intake, with differentiation between animal-derived protein fractions and plant-based sources. Additionally, the composition and adequacy of dietary lipids were analyzed, focusing distinctly on total fats, the proportion of vegetable-derived fats, and cholesterol levels. Carbohydrate intake was rigorously differentiated into categories including simple sugars (mono- and disaccharides), complex carbohydrates (polysaccharides), dietary fibers, and pectic substances.

The energetic sufficiency of the diets was quantified through meticulous calculations of daily caloric intake, expressed in kilocalories per day (kcal/day), which is critical for determining overall dietary adequacy and nutritional balance.

Vitamin adequacy evaluations incorporated an extensive range of both fat-soluble and water-soluble vitamins, including retinol equivalents (vitamin A), β-carotene, ascorbic acid (vitamin C), cholecalciferol (vitamin D), tocopherol (vitamin E), thiamine (vitamin B1), riboflavin (vitamin B2), pyridoxine (vitamin B6), cyanocobalamin (vitamin B12), niacin equivalents (vitamin PP), and folic acid. Additionally, detailed mineral analyses were conducted to quantify dietary levels of essential minerals such as calcium, phosphorus, iron, and magnesium, each playing crucial physiological roles in human metabolism and health maintenance.

To further enhance the analytical robustness and scientific validity, dietary assessments were performed considering seasonal variability in nutrient intake patterns. For accurate nutrient quantification, data was systematically extracted and cross-validated using authoritative food composition tables compiled by Pokrovsky (1977) [4], which remain a recognized standard reference within nutritional science.

This integrated and comprehensive methodological approach provided an authoritative foundation for assessing dietary adequacy, contributing valuable insights into nutritional status evaluations aligned with both national standards and globally recognized nutritional reference frameworks.

### Intervention Procedures

Initially, all study participants received standardized educational sessions designed to improve awareness about balanced nutrition, proper dietary habits, and accurate dietary recording practices. Educational content was delivered through interactive group discussions, visual aids, and printed materials distributed among the participants.

Subsequently, participants received specialized prophylactic food products (SPFP) developed from locally available freeze-dried fruits and vegetables. These products, created in collaboration with the local producer (YUMA BIO), were specifically formulated to address identified nutritional deficiencies, particularly targeting vitamins A, C, E, and B-complex vitamins, as well as essential minerals.

### Laboratory Verification

To validate the accuracy of self-reported dietary intakes,

selected food samples representing typical daily diets were subjected to comprehensive laboratory nutritional analysis. These analyses were carried out using advanced analytical techniques, including gas chromatography, atomic absorption spectroscopy, and spectrophotometric assays, at the accredited laboratory facilities of the Research Institute of Sanitation, Hygiene, and Occupational Diseases, Ministry of Health of Uzbekistan.

**Statistical Analysis**

Descriptive statistics, including means and standard errors (M±m), were calculated. Differences between groups (before and after interventions) were assessed using paired and independent Student's t-tests. Statistical significance was set at a threshold of $p < 0.05$.

# 4. Research Results

The analysis of laboratory and statistical data obtained demonstrated minor discrepancies between calculated and laboratory-analyzed nutritional values, all within acceptable methodological variances (Table 1).

**Table 1.** Nutritional and Biological Values of Daily Diets of Agricultural Workers Before Educational Intervention (M±m)

| Indicators | Calculated | Laboratory | p-value |
|---|---|---|---|
| Energy (kcal/day) | 2420±40 | 2370±45 | <0.05 |
| Total proteins, g | 79.3±1.3 | 78.4±1.5 | ns |
| Animal proteins, g | 43.2±1.2 | 41.5±1.3 | ns |
| Total fats, g | 76.4±1.2 | 74.8±1.5 | ns |
| Vegetable fats, g | 18.4±0.8 | 18.2±0.9 | ns |
| Carbohydrates, g | 420.0±16.0 | 419.0±18.8 | ns |
| Protein:Fat:Carb ratio | 1:0.9:5.0 | 1:0.9:5.0 | ns |
| Vitamin A, µg eq | 470.0±55 | 410±35 | <0.05 |
| β-carotene, mg | 2.4±0.05 | 1.9±0.04 | <0.001 |
| Vitamin C, mg | 48.8±2.0 | 41.0±3.0 | <0.001 |
| Vitamin E, mg | 7.6±0.4 | 7.0±0.3 | <0.001 |
| Vitamin D, mg | 1.7±0.2 | 1.6±0.1 | ns |
| Vitamin B1, mg | 1.5±0.04 | 1.1±0.05 | <0.001 |
| Vitamin B2, mg | 1.6±0.05 | 1.2±0.06 | <0.001 |
| Vitamin B6, mg | 1.5±0.05 | 1.2±0.06 | <0.001 |

Daily dietary intakes revealed significant macronutrient imbalances, primarily characterized by excessive carbohydrate consumption (62.3±1.3%, recommended ≤55%) and suboptimal fat intake (25.3±0.7%, recommended 26–27%). This persistent dietary pattern remained unchanged following a one-month intensive educational intervention, highlighting the limited effectiveness of education alone in changing deeply entrenched dietary habits.

To address the identified nutrient deficiencies, specialized prophylactic food products (SPFP) formulated with freeze-dried local fruits and vegetables were introduced. The supplementation led to significant improvements in dietary nutritional quality, notably increasing intake of critical vitamins and micronutrients (Table 2).

**Table 2.** Nutritional and Biological Values of Daily Diets After Educational Intervention and Additional Provision of SPFP (M±m)

| Indicators | After education | After SPFP | p-value |
|---|---|---|---|
| Energy (kcal/day) | 2540±40 | 2580±50 | <0.05 |
| Total proteins, g | 84.0±1.2 | 84.3±1.0 | ns |
| Animal proteins, g | 47.7±1.3 | 48.1±1.1 | ns |
| Total fats, g | 74.8±1.2 | 75.6±1.3 | ns |
| Vegetable fats, g | 18.8±1.1 | 19.2±0.9 | ns |
| Carbohydrates, g | 510.0±6.8 | 512.0±18.8 | ns |
| Protein:Fat:Carb ratio | 1:0.9:5.2 | 1:0.9:5.2 | ns |
| Vitamin A, µg eq | 420±30 | 490.0±34 | <0.05 |
| β-carotene, mg | 2.1±0.03 | 2.7±0.07 | <0.001 |
| Vitamin C, mg | 61.4±3.1 | 69.2±2.5 | <0.001 |
| Vitamin E, mg | 7.2±0.3 | 7.8±0.3 | <0.001 |
| Vitamin D, mg | 1.6±0.1 | 1.7±0.3 | ns |
| Vitamin B1, mg | 1.1±0.05 | 1.5±0.05 | <0.001 |
| Vitamin B2, mg | 1.2±0.06 | 1.6±0.07 | <0.001 |
| Vitamin B6, mg | 1.2±0.06 | 1.5±0.08 | <0.001 |

# 5. Discussion

The study results underscore critical challenges in altering established dietary habits among rural populations solely through education. Persistent excessive carbohydrate intake and insufficient fat and micronutrient consumption reflect deeply embedded dietary practices, cultural habits, and socioeconomic constraints prevalent in rural communities. These findings align with previous research emphasizing the limited effectiveness of purely educational interventions in sustainably modifying nutritional behaviors [5,6].

However, targeted nutritional supplementation using specialized prophylactic food products demonstrated significant efficacy, substantially improving the micronutrient profiles of participants' diets. Such findings confirm WHO and FAO recommendations regarding integrated approaches combining educational activities and nutritional supplementation or fortification for improved public health outcomes [9,10]. The current study's successful use of locally sourced ingredients further highlights the potential for sustainable nutritional interventions leveraging local agriculture, thus supporting broader national goals outlined by Uzbekistan's Presidential Decree №UP-36 on food security and agricultural modernization [11].

# 6. The Study Yielded the Following Results

Dietary imbalances among agricultural workers were resistant to educational interventions alone, specifically in terms of high carbohydrate (62.3±1.3%) and low fat intake

(25.3±0.7%).

Educational interventions alone did not significantly alter entrenched dietary practices.

Supplementation with specialized prophylactic food products (SPFP) significantly improved dietary micronutrient profiles, notably vitamins A, β-carotene, C, E, B1, B2, and B6.

## 7. Conclusions

Nutritional imbalances among Uzbekistan's agricultural workers are deeply rooted in traditional dietary habits, notably reflected in excessive carbohydrate and insufficient fat intake. Educational measures alone are inadequate to achieve significant improvements in nutritional behavior within rural communities. The introduction of specialized prophylactic food products formulated from local agricultural produce represents an effective, sustainable approach for addressing persistent micronutrient deficiencies and improving overall dietary quality, thereby enhancing rural public health and productivity.

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