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Evaluation of the Effects of Input Subsidy Policy versus Direct Payment on the Cropping Pattern of Agricultural Products (Case Study: Dehgolan Plain, Kurdistan Province)

Shiva Ramaei[1], Hamed Najafi Alamdarlo[2] ✉, Mohammad Hasan Vakilpour [3]

1. Department of Agricultural Economics, Tarbiat Modares University, Tehran, Iran. E-mail: shiva.r.1397@modares.ac.ir
2. Corresponding Author, Department of Agricultural Economics, Tarbiat Modares University, Tehran, Iran. E-mail: hamed_najafi@modares.ac.ir
3. Department of Agricultural Economics, Tarbiat Modares University, Tehran, Iran. E-mail: vakilpoormh@modares.ac.ir

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ABSTRACT

Governments can influence agricultural production levels and cropping patterns through a range of policy instruments, including direct payments, input subsidies, export subsidies, and other support measures. Such policies may alter cropping decisions and improve farm income. In this study, using a Positive Mathematical Programming (PMP) model, the effects of a change in government support policy were examined under four scenarios— (1) continuation of the current input subsidy policy, (2) full removal of input subsidies, (3) implementation of direct payments to farmers, and (4) simultaneous implementation of direct payments with cropping pattern adjustment—on farm profitability and resource allocation during the 2023–2024 crop year. The results of the policy scenarios show that, in response to the change in the support regime, the cultivated area of irrigated wheat, irrigated bean, rainfed bean, and rainfed barley increased. In contrast, the cultivated area of rainfed wheat, irrigated barley, potato, cucumber, alfalfa, and onion declined. These changes indicate a shift in the cropping pattern toward crops with higher economic returns, lower production risk, and greater compatibility with resource constraints and the framework of the direct payment policy, suggesting that a change in support policy can guide farmers' production behavior toward more efficient resource allocation. The scenarios also led to a reduction in chemical fertilizer use, which is environmentally important. Moreover, replacing input subsidies with direct payments was found to be an effective and efficient approach in terms of both economic performance and environmental sustainability, as it supports farm income while reducing the use of chemical fertilizers, pesticides, and fossil fuels. This, in turn, improves environmental conditions and enhances the sustainability of natural resources in the study area.

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Introduction

Iranian agriculture has faced rising input costs in recent years. This challenge has placed considerable pressure on production costs and has had adverse effects on the sustainability of production and the economic efficiency of agricultural activities, particularly in the allocation of inputs and the profitability of producers (Amiri et al., 2020; Kalantar et al., 2025). In this context, input subsidies, especially subsidies on chemical fertilizers and fuel, have in many cases not only failed to improve productivity but have also encouraged excessive input use, leading to environmental problems and reduced economic efficiency in agricultural activities (Nouripour et al., 2021; Aghabeygi et al., 2022). These policies have, in the short term, caused unstable changes in farmers' input use and, in the long term, have led to excessive use of inputs and increased pressure on natural resources (Azik et al., 2021; Nejabat et al., 2022). One of the main problems is the misallocation of subsidies.

In semi-arid regions of Iran, limitations in water resources and climate change have made farmers dependent on subsidies (Ailbakhshi et al., 2020; Karimi et al., 2024; Gholami et al., 2025); however, concerns regarding the adverse effects of excessive use of chemical inputs and the resulting environmental damage are increasing (Bisht & Chauhan, 2020; Ugwuoke et al., 2024). A large body of research aimed at mitigating the negative consequences of input subsidies has examined and compared the effects of various policy instruments, showing that replacing input subsidies with different forms of direct payments or income support can influence cropping patterns, input consumption, and farmers' production behavior (Mamun et al., 2021; Alta et al., 2021; Ciliberti et al., 2022; Vos et al., 2023; Alawode, 2025). These findings indicate that direct payments, when designed according to regional characteristics, can reduce input use and stabilize farmers' income. These systems allocate payments to farmers based on environmental and economic conditions, thereby contributing to sustainable economic and environmental production. In Iran, many studies have addressed the inefficiency of subsidies and their structural problems (Azik et al., 2021; Shemshadi et al., 2021; Bakeshloo et al., 2022; Shabanzadeh-Khoshrody et al., 2024; Tajmazinani, 2024). These studies show that although subsidies may provide short-term support to farmers, they lead to economic and environmental problems in the long term.

One of the proposed policies for reforming agricultural support systems is the elimination of chemical fertilizer subsidies and their replacement with direct payments to farmers (Sadłowski et al., 2021; Liang & Meng, 2024). Under this policy, by liberalizing the prices of chemical inputs and removing their subsidies, cash transfers are provided to farmers based on cultivated area, production levels, and in accordance with the baseline cropping pattern (Ardali & Tarazkar, 2024; Alawode, 2025). These payments are transferred directly to farmers' bank accounts through banking systems. Given the need for government support for farmers alongside limited public resources, the efficient use of governmental resources and their targeted allocation are essential. Prior to implementing such policies, it is necessary to assess their potential impacts on input consumption, scarce natural resources such as water and land, and changes in cropping patterns, particularly for strategic crops, so that policymakers can select optimal policy options (Cuadros-Casanova et al., 2023).

This study was conducted to examine the impact of shifting from input subsidy policies to direct payments in Dehgolan Plain, located in Dehgolan County, Kurdistan Province, Iran. This Plain is one of the major agricultural production regions in western Iran, where a significant portion of households' livelihoods depends on agricultural activities (Ghadermazi et al., 2020). The dominant agricultural structure in this plain is based on the cultivation of staple crops; however, the region faces constraints such as limited water resources, increasing pressure on production inputs, and a high dependence of farmers on government support policies (Ghasabi et al., 2025). Under such conditions, changes in support policies, particularly the replacement of input subsidies with direct payments, may have substantial impacts on cropping patterns, input use, resource allocation, and farmers' income. Accordingly, Dehgolan Plain was selected as the study area due to its high sensitivity to support policies and the critical role of agriculture in the local economy. Although input subsidy policies are implemented with the aim of supporting producers, in many cases they have led to inefficient use of chemical inputs, increased pressure on natural resources, and inefficiencies in resource allocation (Guo et al., 2022; Fan et al., 2024). In contrast, direct payment policies can, while maintaining farmers' income support, guide production incentives toward more rational economic decisions that are more compatible with environmental considerations (Liang & Meng, 2024). However, the actual effects of this policy shift at the farm level and in specific agricultural regions, particularly those with resource constraints, require careful empirical investigation. Evidence suggests that gradual reduction of subsidies, when accompanied by timely support measures, can improve economic efficiency and reduce environmental pressures (Liu et al., 2020; Springmann & Freund, 2022; Bernini & Galli, 2024; Alawode, 2025). Therefore, compared with previous studies, this research employs an economic modeling approach to simulate actual farmer behavior in the base year and to simultaneously analyze the economic and environmental effects of support policies under different scenarios. Unlike many previous studies that have focused solely on income effects, this study provides an integrated analysis of cropping pattern responses, input consumption, and environmental impacts at the regional scale, thereby offering new applied evidence for designing more efficient and sustainable agricultural support policies.

Research Methodology

The aim of this study is to examine the impact of replacing input subsidies (fertilizers and fuel) with direct payments to farmers in Dehgolan Plain. In this research, two direct payment mechanisms, one based on farmers' income and the other based on product price, are compared to determine which approach can improve productivity and economic efficiency through influencing farmers' production behavior. In this regard, the effects of four different scenarios (25, 50, 75, and 100 percent substitution of subsidies with direct payments) on cropping patterns, input use, and farmers' income are simulated and analyzed using a Positive Mathematical Programming (PMP) model. While the objective function of the model is based on profit maximization, the environmental impacts of the policies are assessed indirectly through changes in chemical input use and cropping patterns. The ultimate goal of the research is to analyze farmers' behavioral responses to support policies and to explain the resulting economic and environmental consequences of these responses.

To clarify the overall structure of the study and the implementation steps of the model, a methodological flowchart is presented in Figure (1). This flowchart illustrates the logical sequence of the study, from the collection of baseline data to the implementation of policy scenarios and the extraction of results. According to Figure (1), in the first stage, baseline data including the base-year cropping pattern, yields, prices, input costs, and input usage levels for each crop were collected. These data provide the basis for reproducing actual farmer behavior in the base year. In the second stage, the policy structure of the model was defined, which includes the removal of input subsidies (fertilizers and fuel) and the design of two types of direct payments: income-based payments and product price-based payments. In the third stage, policy scenarios were defined as a gradual substitution of input subsidies with direct payments at four levels of 25%, 50%, 75%, and 100%. These scenarios allow the examination of farmers' gradual responses to changes in support policies. In the fourth stage, the Positive Mathematical Programming model was calibrated. At this stage, parameters of the nonlinear cost function were derived and the model was adjusted in such a way that it accurately reproduces the base-year cropping pattern and reflects actual farmer behavior. In the fifth stage, the final economic model was developed, in which the objective function of farm profit maximization, including profits from agricultural activities plus direct payments, was defined under the calibrated PMP framework. In addition, constraints related to land availability, irrigation water, and input use were incorporated into the model. In the sixth stage, the model was solved for different policy scenarios, and outputs such as changes in crop areas, farmers' gross income, and input use levels (fertilizers, fuel, and irrigation water) were extracted and analyzed. This stepwise framework enables a systematic and integrated assessment of the economic, behavioral, and environmental effects of the examined support policies at the regional level.

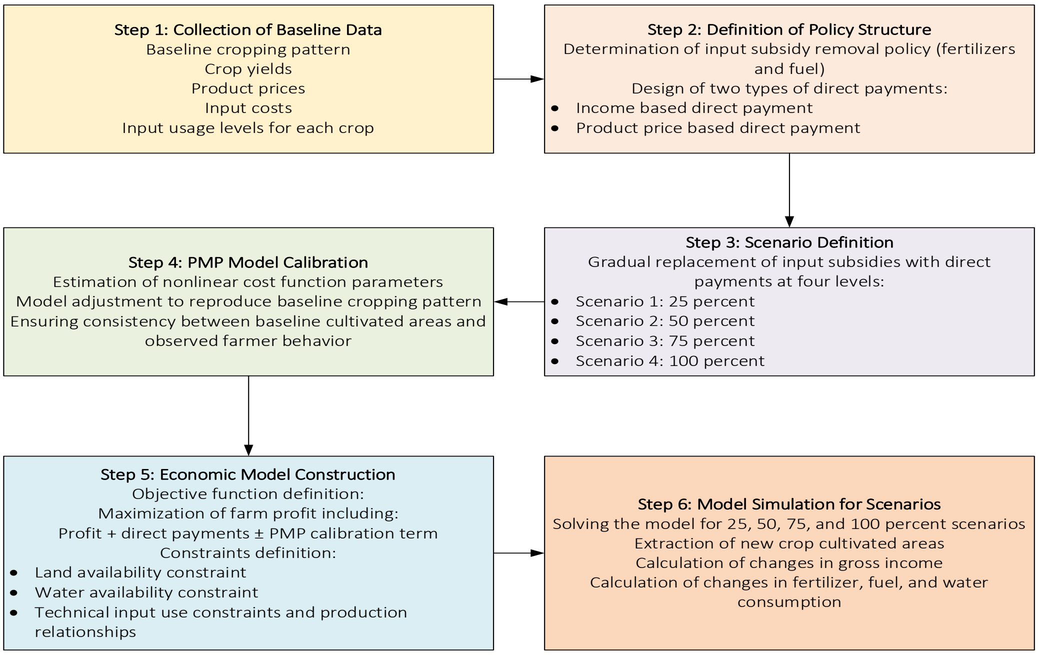

Fig. 1- Flowchart of methodology

Case Study

Dehgolan County is located between 47.3° to 48.4° east longitude and 35.2° to 36.6° north latitude. The county consists of two cities, two districts, five rural districts, and 107 villages. The urban population of Dehgolan County is approximately 26,281 people, while its rural population is about 36,563 people (Kalantari et al., 2024; Ghahroudi Tali et al., 2023). This region is one of the most important agricultural areas in Kurdistan Province, covering an area of 2,876 square kilometers with 152,000 hectares of agricultural land, which provides suitable conditions for analyzing agricultural support policies (MAJK, 2024). Water resource limitations and climate change in this region have led to farmers' dependence on government subsidies and the adoption of inefficient cropping patterns (Yousefi Mobarhan et al., 2023; Valadi et al., 2024). The characteristics of this region make the analysis of changes in support policies, particularly direct payments, highly important in terms of their effects on farmers' behavior and cropping patterns.

The study area in this research is Dehgolan Plain, located in Kurdistan Province, which is recognized as one of the most important and highly mechanized agricultural plains in this province (Ghahroudi Tali et al., 2023; Tahmasbi et al., 2025). The statistical population of the study includes all farmers engaged in the cultivation of major crops. According to official statistics from the Kurdistan Province Agricultural Jihad Organization and field studies conducted in the 2023-2024 agricultural year, the total number of farmers cultivating these crops is estimated at approximately 2,850 (MAJK, 2024). The sample size was calculated using Cochran's formula, resulting in 150 respondents. After excluding incomplete questionnaires, 125 valid questionnaires were used for the final analysis. To ensure the adequacy of the sample size and the existence of a significant correlation among the questionnaire variables used in model calibration, the Kaiser-Meyer-Olkin (KMO) test was conducted, yielding a value of 0.81, and Bartlett's test of sphericity was performed at the 1 percent significance level. The results confirmed the adequacy of the data. Sampling was carried out using a two-stage stratified method. In the first stage, Dehgolan Plain was divided into three northern, central, and southern zones based on geographical location and climatic characteristics. In the second stage, several villages were randomly selected from each zone, and from each village, farmers were randomly chosen in proportion to the number of farmers for face-to-face interviews. Data related to cultivated area, yield, price, production costs, water consumption, fertilizers, pesticides, labor, machinery, and fuel were collected through questionnaires and then cross-checked and adjusted using secondary data from sources such as the Provincial Agricultural Organization, the Regional Water Authority, and the Statistical Center of Iran. Data for each farm were aggregated at the regional level using a weighted average of crop cultivated areas, and input variables were converted into equivalent indices using standardized consumption units to make them suitable for use in the Positive Mathematical Programming model. A Positive Mathematical Programming model was used to simulate the effects of subsidy and direct payment policies. In this model, two types of support vectors were defined. The first was input subsidies, including subsidies for urea fertilizer and machinery fuel, which were allocated to farmers as a percentage of total production costs. The second was direct payments to farmers, designed under four policy scenarios with 25,% 50%, 75%, and 100%substitution of input subsidies with direct payments. Within the direct payment framework, two support mechanisms were examined. In the first case, direct payments were based on farmers' income. In the second case, direct payments were based on product price, in a way that the government provided compensatory payments per unit of output, supporting farmers' income without reducing the market price received by farmers. In this approach, the market price is maintained as the decision-making signal for farmers, while government support is implemented as a transfer payment independent of market prices. The values of the support vectors were calibrated based on actual data from the agricultural year and regional base prices, and questionnaire data were used to estimate technical and cost parameters. These data were then used to simulate the effects of different scenarios of direct payments and input subsidies within the Positive Mathematical Programming framework in order to evaluate their impacts on cropping patterns, farmers' income, and resource productivity in Dehgolan Plain.

Positive Mathematical Programming (PMP) models are widely used in agricultural studies to accurately simulate farmers' responses to changes in government policies, including direct payments and input subsidies (Szerletics & Jambor, 2020; Arribas et al., 2020; Baldi et al., 2023). The PMP model has been specifically designed and calibrated for the agricultural conditions of Dehgolan Plain in order to more precisely simulate farmers' behavior in response to policy changes. In this process, farmers are considered economic decision makers who adjust their decisions regarding crop allocation, input consumption, and resource allocation in response to changes in support policies.

The objective function of the study is formulated as Equation (1). For further technical details of this method, readers are referred to (Howitt, 1995; Žgajnar & Zadnik Stirn, 2024; Yao et al., 2025; Kalantar et al., 2025; Zare Mehrjerdi et al., 2025; Kalantar et al., 2026).

$$Max \quad GM = \sum_{i=1}^{10} P_i Y_i X_i - \sum_{i=1}^{10} C_{ij} X_i + D_i \tag{1}$$

In eq.1, the objective function (GM) is defined based on the maximization of farmers' gross profit. In this formulation, P_i denotes the price per unit of crop i, X_i represents the cultivated area of crop i, and Y_i indicates the yield of crop i per hectare. In addition, C_{ij} represents production costs, including input costs such as land, water, labor, machinery, chemical fertilizers, and pesticides for crop i. Based on these components, farmers' gross profit is calculated as the difference between total revenue from crop sales and total production costs. In this model, D_i is defined as a direct payment to farmers for crop i, which is explicitly considered as an additional source of income and is incorporated into the gross profit function. The inclusion of these payments in the objective function implies that D_i can increase farmers' gross profit and consequently influence their economic behavior. These changes include selecting more suitable crops, more efficient allocation of resources, and adjustments in cropping patterns and input use, which ultimately affect farmers' gross income and resource productivity at the regional level. The formulation of the model constraints is presented as follows:

$$\sum_{i=1}^{10} X_i \leq LAND \tag{2}$$

$$\sum_{i=1}^{10} W_i X_i \leq TW \tag{3}$$

$$\sum_{i=1}^{10} L_i X_i \leq TL \tag{4}$$

$$\sum_{i=1}^{10} M_i X_i \leq TM \tag{5}$$

$$\sum_{i=1}^{10} CF_{iJ} X_i \leq TCFRT \tag{6}$$

$$\sum_{i=1}^{10} T_{iJ} X_i \leq TPest \tag{7}$$

The cultivated area for each crop, measured in hectares, was estimated using land use maps, geographic data, and information related to the physical characteristics of land, including soil type and slope, within homogeneous spatial units. This information was used to determine the spatial distribution and the actual cultivated area of crops in the study region (LAND). In this study, the average three year cultivated area data for crops was used solely to identify dominant crops in the region and to reconstruct the base year cropping pattern (2023–24) during the model calibration stage. In the positive mathematical programming model, land is defined as the total available arable land in the region, and its allocation among different crops is determined endogenously based on farmers' optimal behavior under different policy scenarios. Total irrigation water is defined as the amount of water available for each crop at its cultivated area and is measured in cubic meters (TW). Naturally, for rainfed crops, due to the absence of irrigation water use, this variable is specified through the model's technical coefficients in a way that they are not constrained by irrigation water availability. Regarding labor, measured in person hours, data were collected based on activity type and skill level (unskilled, semi-skilled, skilled, female, and male workers) and then aggregated into standard labor equivalents (TL). For machinery, measured in hours, given the diversity of equipment, an equivalent hour per hectare index was used to convert all machinery into a unified standard unit (TM). For chemical inputs, fertilizers (nitrogen, phosphorus, and potassium) and pesticides (herbicides, insecticides, and fungicides) were aggregated based on active ingredient content and cost per kilogram or liter. Accordingly, input quantities and costs were incorporated into the model constraints as fertilizer (TCFRT) and pesticide (TPest) constraints.

During the first stage of model calibration, in order to accurately reproduce the observed activity levels in the base year and to avoid linear dependence between structural constraints and calibration constraints, a very small positive bound (ε) is added to the observed activity levels. It should be noted that this constraint is applied only in the first calibration stage for the purpose of deriving shadow prices and estimating the parameters of the nonlinear cost function.

$$X_i \leq X_i^* + \varepsilon \tag{8}$$

In Eq. 8, X_i denotes the activity level or cultivated area of crop i, while X_i^* represents the observed level of the same activity in the base year. The parameter ε is a very small positive number introduced as a calibration bound to prevent perfect collinearity among constraints and to avoid numerical problems during the calibration process.

Given the objective of the study and the different scenarios (substitution of input subsidies with direct payments), the model is used to simulate four alternative scenarios. These scenarios are defined as percentage levels of substitution of input subsidies by direct payments. In the 25%, 50%, 75%, and 100% scenarios, the direct payment (D_i) to farmers is calculated as follows.

$$D_{\mathrm{i}} = \begin{cases} S_{\mathrm{i}}\ 0.25;\ Scenario\ 1\text{: } 25\ percent\ substitution \\ S_{\mathrm{i}}\ 0.50;\ Scenario\ 2\text{: } 50\ percent\ substitution \\ S_{\mathrm{i}}\ 0.75;\ Scenario\ 3\text{: } 75\ percent\ substitution \\ S_{\mathrm{i}}\ 1.00;\ Scenario\ 4\text{: } 100\ percent\ substitution \end{cases} \tag{9}$$

In this relationship, S_i represents the amount of input subsidies for crop i, which includes subsidies for chemical fertilizers and fuel used by agricultural machinery. These subsidies are calculated in Iranian Rials per hectare and are aggregated over the total cultivated area of each crop. In the policy scenarios, a specified proportion of these subsidies is removed, and the equivalent amount is reallocated as direct payments (D_i) in the farmers' gross profit function. The main objective of this model is to accurately identify which direct payment scenario has the greatest positive impact on farmers' gross profit, cropping pattern, and resource productivity in the Dehgolan Plain.

Results and Discussion

The high consistency between the observed base year cultivated areas and those simulated by the PMP model, as presented in Figure (2), indicates the model's satisfactory accuracy in reconstructing farmers' production behavior under baseline conditions. In this study, ten crops including irrigated wheat, rainfed wheat, irrigated barley, rainfed barley, irrigated bean, rainfed bean, potato, alfalfa, cucumber, and onion, which were present in the base cropping pattern of the region, were analyzed. These data indicate that each crop was cultivated only in areas of the plain that were suitable in terms of soil texture, water availability, and physiological conditions; therefore, land-related constraints in the PMP model were defined based on the actual suitability classes of each crop and their available cultivable area. Subsidies in this year were allocated to urea fertilizer, and fuel subsidies were also considered within the machinery input component.

In this study, the effects of substituting direct payments for input subsidies on farmers' gross income and crop prices were examined under four scenarios of 25%, 50%, 75%, and 100% replacement (Table 1). The design of these scenarios is based on gradual subsidy liberalization policies in the agricultural sector and the implementation framework of the subsidy targeting law in Iran (2010–2023), as well as relevant domestic studies (Bakhshi & Peykani, 2012; Rostami Maskoupai et al., 2019; Azik et al., 2021; KeramatZadeh & Eshraghi, 2023; Ardali & Tarazkar, 2024) and international studies (Szerletics & Jambor, 2020; Santosa & Shimada, 2021; Jambor & Szerletics, 2022; Liang & Meng, 2024). In this framework, Scenario 1 (25% direct payment and 75% input subsidy) represents a partial reduction in subsidies while maintaining price support, whereas Scenario 4 (100% direct payment and complete elimination of input subsidies) reflects a full subsidy removal condition. The design of these scenarios allows for a gradual analysis of the effects of alternative policy interventions on farmers' production behavior and cropping pattern changes under different support regimes. In each scenario, depending on the extent of subsidy reduction, the difference between subsidized and free market prices of inputs (urea fertilizer and fuel) is transferred to farmers as direct payments. These payments are directly added to farmers' gross income and crop prices. This approach provides a more precise assessment of the impact of subsidy liberalization and its conversion into direct payments on farm profitability and cropping patterns under different subsidy regimes.

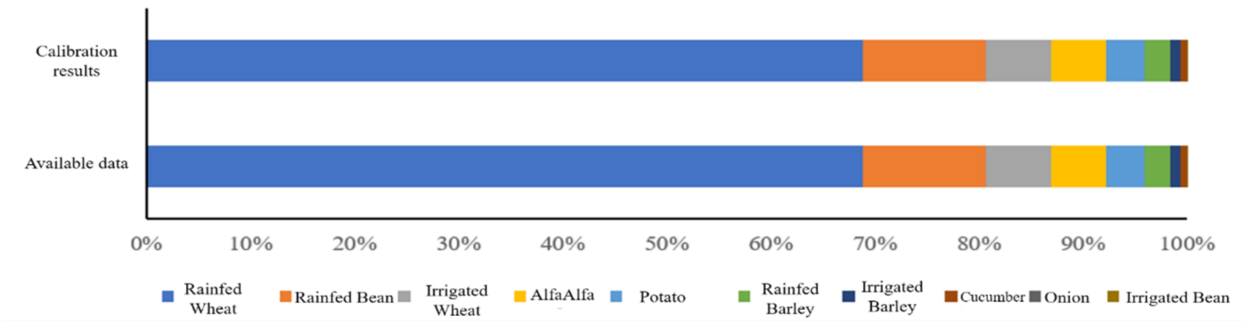

Fig. 2- Result of PMP model calibration (Ha)

Table 1- Scenarios under consideration and products subject to the direct payment policy

Basic model	How to apply the scenario
Scenario 1	75% Input subsides + 25% Direct payment
Scenario 2	50% Input subsides + 50% Direct payment
Scenario 3	25% Input subsides + 75% Direct payment
Scenario 4	100% Direct payment

Table 2 presents the percentage changes in cultivated area of different crops under various direct payment scenarios in the first case, where direct payments are allocated to farmers' income. These scenarios are simulated at four levels: 25%, 50%, 75%, and 100%. Based on the results of this table, it can be observed that the direct payment policy has affected the cultivated area of agricultural crops.

Table 2- Changes in cultivated area in each scenario at first Status (Ha)

Crop	Basic model	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Irrigated Wheat	6970	7350 (5.45%)	7561 (8.48%)	8078 (15.9%)	8560 (22.81%)
Rainfed Wheat	76012	75000 (-1.33)	74000 (-2.65%)	73000 (-3.96%)	72000 (-5.28%)
Irrigated Bean	9	9 (0)	9 (0)	9 (0)	9 (0)
Rainfed Bean	13024	12800 (-1.72%)	12650 (-2.87%)	12500 (-4.02%)	1237 (-5.02%)
Irrigated Barley	1021	1010 (-1.08%)	1000 (-2.06%)	990 (-3.04%)	975 (-4.51%)
Rainfed Barley	2750	2904 (5.65%)	3350 (21.21%)	3500 (27.27%)	3850 (40%)
Potato	4118	4100 (-0.44%)	4070 (-1.17%)	4030 (-2.14%)	4000 (-2.87%)
Cucumber	650	635 (-2.31%)	620 (-2.64%)	605 (-6.92%)	590 (-9.23%)
Alfalfa	5852	6600 (12.78%)	7150 (22.18%)	7700 (31.58%)	8060 (37.73%)
Onion	58	56 (-3.45%)	54 (-6.9%)	52 (-10.34%)	50 (-13.79%)

Source: Calculations and findings of the study

The results presented in Table 2 indicate that the direct payment policy targeted at farmers' income has affected the cultivated area of different crops. Irrigated wheat shows the most significant change in cultivated area, and in Scenario 4 (100% direct payment), its cultivated area increased by 22.81%, which potentially indicates the attractiveness of this crop for farmers under increased income resulting from direct payments. In contrast, rainfed wheat experienced a reduction in cultivated area across all scenarios, reaching a 5.28% decrease in Scenario 4, which reflects the high sensitivity of this crop to support policies. Irrigated bean and alfalfa exhibited relatively smaller changes in cultivated area and showed lower responsiveness to variations in direct payments. On the other hand, cucumber and onion experienced the largest reductions in cultivated area, such that in Scenario 4, cucumber decreased by 9.23% and onion by 13.79%. These changes clearly indicate the sensitivity of these crops to variations in subsidy policies. In contrast, rainfed barley recorded the highest increase in cultivated area, with an increase of approximately 40% in Scenario 4 compared to the base model. This finding suggests a positive response of the cropping pattern to the full implementation of direct payment policy alongside the removal of input subsidies. It also indicates that, within the model assumptions, rainfed barley, as a crop with lower input requirements and higher adaptability to resource constraints, achieves a more favorable position in farmers' decision-making process. Overall, changes in cultivated area across different crops demonstrate the significant and heterogeneous effects of direct payment policy on cropping patterns. These changes not only have a direct impact on agricultural productivity but may also influence natural resources and the sustainability of agricultural production.

Table 3 presents the percentage changes in cultivated area of different crops under various direct payment scenarios in the second case. In this case, payments are applied to crop prices, and the analysis is conducted under four scenarios of 25%, 50%, 75%, and 100% implementation. This analysis examines the effects of direct payments on product prices on the cultivated area of agricultural crops in the Dehgolan Plain.

Table 3- Changes in cultivated area in each scenario at second Status (Ha)

Crop	Basic model	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Irrigated Wheat	6970	7493 (7.50%)	8015 (14.99%)	8538 (22.50%)	9061 (30.00%)
Rainfed Wheat	76012	75076 (-1.23%)	74100 (-2.46%)	73203 (-3.70%)	72267 (-4.93%)
Irrigated Bean	9	10 (11.11%)	10 (11.11%)	11 (22.22%)	12 (33.33%)
Rainfed Bean	13024	12846 (-1.23%)	12703 (-2.46%)	12543 (-3.69%)	12382 (-4.93%)
Irrigated Barley	1021	1008 (-1.27%)	996 (-2.45%)	983 (-3.72%)	971 (-4.90%)
Rainfed Barley	2750	2956 (7.49%)	3162 (14.98%)	3369 (22.51%)	3575 (30.00%)
Potato	4118	4067 (-1.24%)	4017 (-2.45%)	3966 (-3.69%)	3915 (-4.93%)
Cucumber	650	642 (-1.23%)	634 (-2.46%)	626 (-3.69%)	618 (-4.92%)
Alfalfa	5852	6291 (7.50%)	6730 (15.00%)	7169 (22.51%)	7608 (30.01%)
Onion	58	57 (-1.72%)	57 (-1.72%)	56 (-3.45%)	55 (-5.17%)

Source: Calculations and findings of the study

In Table 4, irrigated wheat shows the highest increase in cultivated area, rising by 30% in scenario 4, indicating farmers' responsiveness to direct payments linked to product prices. In contrast, irrigated barley and rainfed wheat experienced a decline in cultivated area, with reductions of 4.90% and 4.93%, respectively, reflecting the impact of changes in direct payment policies tied to product prices on these crops. Cucumber also recorded a decrease of 4.92% in cultivated area, highlighting the negative effect of price based direct payments on this crop. On the other hand, alfalfa and onion exhibited an increase in cultivated area across different scenarios. Alfalfa increased by 30.01% in scenario 4, while irrigated bean showed an increase of 33.33% in cultivated area. Overall, these results indicate that farmers respond to price based direct payments in ways that significantly affect cropping patterns and resource allocation.

Table 4 presents the changes in the use of different inputs under direct payment scenarios based on farmers' income in the first case. In this case, direct payments are allocated to farmers' income, and variations in input use are calculated across different scenarios (25%, 50%, 75%, and 100%). This table illustrates the effects of direct payments on input consumption patterns and how changes in farmers' income can influence their decisions regarding input use and allocation.

Table 4- Changes in inputs use in each scenario at first Status

Inputs	Basic model	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Water (m^3)	148643630	148643630 (-0.01%)	148450250 (-0.01%)	148437350 (-0.02%)	148420330 (-0.03%)
Subsided nitrogen fertilizer (Kg)	3890722	3890700 (-0.01%)	3890650 (-0.01%)	3890580 (-0.01%)	3890480 (-0.01%)
Nitrogen fertilizer (Kg)	5569914	5563200 (-0.12%)	5555090 (-0.27%)	5545590 (-0.44%)	5534700 (-0.63%)
Phosphate fertilizer (Kg)	1037626	1035900 (-0.17%)	1033760 (-0.37%)	1031200 (-0.62%)	1028230 (-0.91%)
Potassium fertilizer (Kg)	1442907	1440510 (-0.17%)	1437620 (-0.37%)	1434240 (-0.60%)	1430370 (-0.87%)
Insecticide (liters)	106832	106780 (-0.05%)	106710 (-0.11%)	106620 (-0.20%)	106510 (-0.30%)
Fungicide (kilograms)	96691	96640 (-0.05%)	96580 (-0.11%)	96500 (-0.20%)	96400 (-0.30%)
Herbicide (liters)	159169	159090 (-0.05%)	158990 (-0.11%)	158860 (-0.19%)	158700 (-0.29%)
Machinery (Hour)	767291	766580 (-0.09%)	765650 (-0.21%)	764500 (-0.36%)	763130 (-0.54%)
Labor (Person/Day)	708699	707880 (-0.12%)	706810 (-0.27%)	705490 (-0.45%)	703920 (-0.67%)

Source: Calculations and findings of the study

The results in Table 4 indicate that, under the scenarios of replacing input subsidies with direct payments, changes in input use are generally limited and, in most cases, close to zero. In contrast, the observed changes in other inputs, such as water, pesticides, machinery, and labor, occur mainly indirectly through substitution and complementarity relationships among inputs within the production process. The limited variation in non-target inputs suggests that replacing input subsidies with direct payments, without causing a severe shock to the production structure, leads to a gradual rebalancing of input combinations and improves allocative efficiency. In fact, rather than significantly reducing total input use, this policy adjusts farmers' production behavior within existing technical and technological constraints and influences input use patterns through indirect channels.

Table 5 presents the changes in input use under different scenarios in the second case, where direct payments are applied based on product prices. This table examines the effects of direct payments on input consumption and farmers' production patterns. For each input, changes across scenarios (25%, 50%, 75%, and 100% direct payment to product price) are analyzed in order to provide a more detailed understanding of the impact of these policies on farmers.

Table 6 presents the percentage changes in gross income for each crop under income-based direct payments across different scenarios. The percentage changes in gross income for each crop relative to the base year are examined across different scenarios (25%, 50%, 75%, and 100% direct payment).

Table 5- Changes in inputs use in each scenario at second Status

Inputs	Basic model	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Water (m^3)	148643630	148200120 (-0.18%)	147850250 (-0.41%)	147414110 (-0.71%)	146891760 (-1.06%)
Subsided nitrogen fertilizer (Kg)	3890722	3885200 (-0.14%)	3878150 (-0.32%)	3869580 (-0.54%)	3859500 (-0.80%)
Nitrogen fertilizer (Kg)	5569914	5510100 (-1.07%)	5435090 (-2.42%)	5344910 (-4.04%)	5239580 (-5.93%)
Phosphate fertilizer (Kg)	1037626	1025080 (-1.21%)	1009450 (-2.72%)	990750 (-4.52%)	968990 (-6.61%)
Potassium fertilizer (Kg)	1442907	1425550 (-1.20%)	1403550 (-2.73%)	1376930 (-4.57%)	1345710 (-6.74%)
Insecticide (liters)	106832	105450 (-1.29%)	103680 (-2.95%)	101520 (-4.97%)	98980 (-7.35%)
Fungicide (kilograms)	96691	95480 (-1.25%)	93940 (-2.85%)	92070 (-4.78%)	89880 (-7.04%)
Herbicide (liters)	159169	157150 (-1.27%)	154580 (-2.88%)	151470 (-4.84%)	147820 (-7.13%)
Machinery (Hour)	767291	757800 (-1.24%)	745650 (-2.82%)	730850 (-4.75%)	713410 (-7.02%)
Labor (Person/Day)	708699	699950 (-1.23%)	688750 (-2.81%)	675110 (-4.74%)	659040 (-7.01%)

Source: Calculations and findings of the study

Table 6- Changes in Gross margin in each scenario at first Status (%)

Crops	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Irrigated Wheat	1.15	2.23	3.33	4.02
Rainfed Wheat	-1.32	-2.64	-3.96	-5.26
Irrigated Bean	0	0	0	0
Rainfed Bean	-1.71	-2.87	-3.95	-5.15
Irrigated Barley	-1.08	-2.06	-3.04	-4.51
Rainfed Barley	1.82	3.64	5.45	7.27
Potato	-0.44	-1.16	-2.13	-2.86
Cucumber	-2.31	-4.62	-6.92	-9.23
Alfalfa	0.82	1.67	2.53	3.38
Onion	-3.45	-6.90	-10.34	-13.79

Source: Calculations and findings of the study

The results in Table 6 indicate that the gross income of irrigated wheat increased by about 4.02% in scenario 4. Although this increase is more limited compared to the expansion in cultivated area, it suggests that a direct payment policy based on cultivated area plays a more effective role in stabilizing and expanding the production of strategic crops rather than generating a substantial income surge. Structural constraints in the income generation of irrigated wheat also limit the proportional increase in its gross income. In contrast, rainfed wheat experienced a decline in gross income across all scenarios. In scenario 4, this decrease reached 5.26%, indicating a negative impact of direct payments on this crop. For irrigated bean, gross income remained unchanged, suggesting that the policy had no significant effect on this crop. Rainfed bean also experienced a decline in income, reaching 5.15% in scenario 4, similar to rainfed wheat, reflecting a negative effect of direct payments. Both irrigated barley and rainfed barley showed income changes; however, rainfed barley experienced a consistent increase in all scenarios. In scenario 4, its gross income increased by 7.27%, indicating a positive response of farmers to direct payments in this crop. In contrast, irrigated barley decreased by 4.51% in scenario 4. In potato production, income changes were relatively small; however, in scenario 4, this crop experienced a decrease of 2.86%, indicating a negative effect of direct payments. Cucumber was also strongly affected, with a 9.23% decrease in gross income in scenario 4, showing adverse effects of direct payments on its production. Alfalfa showed a positive response, with gross income increasing by 3.83% in scenario 4, indicating a favorable reaction of farmers to direct payments. Onion, however, experienced a substantial decline of 13.79% in gross income, reflecting a strong negative impact of direct payments on this crop.

Table 7 presents the percentage changes in total gross income for each crop (for the total cultivated area allocated to each crop in each scenario) relative to the base year under different direct payment scenarios based on product prices. In this table, the effects of direct payments to farmers, implemented as price based direct payments, on the gross income of different crops are examined.

Table 7- Changes in Gross margin in each scenario at second Status (%)

Crops	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Irrigated Wheat	7.54	15.08	22.61	30.15
Rainfed Wheat	-1.21	-2.43	-3.64	-4.68
Irrigated Bean	11.1	11.1	22.2	33.3
Rainfed Bean	-1.23	-2.45	-3.68	-4.91
Irrigated Barley	-1.4	-2.34	-3.74	-4.67
Rainfed Barley	7.41	14.81	22.2	30.2
Potato	-1.25	-2.49	-3.74	-4.98
Cucumber	-1.13	-2.26	-3.95	-5.08
Alfalfa	7.41	15.1	22.5	29.9
Onion	-1.87	-1.87	-3.74	-5.61

Source: Calculations and findings of the study

The results indicate that the price based direct payment policy has heterogeneous effects on the gross income of different crops. Irrigated wheat shows an increase in gross income, reaching 30.15% growth in scenario 4. In contrast, rainfed wheat experiences a decline in gross income, with a reduction of 4.86% in scenario 4. Irrigated bean exhibits the highest increase among all crops, with its gross income rising by 33.33% in scenario 4, whereas rainfed bean shows a decline in gross income, decreasing by 4.91% in the same scenario. Irrigated barley experiences a reduction in gross income, with a 4.67% decrease in scenario 4, while rainfed barley shows an increase of 30.25% in gross income. Potato production records a decline of 4.98% in gross income in scenario 4, while cucumber experiences a decrease of 5.08%. Alfalfa shows a substantial positive response, with gross income increasing by 29.91% in scenario 4, whereas onion experiences a decline of 5.61%. Overall, these findings demonstrate that farmers' responses to direct payment policies vary significantly depending on crop type, reflecting heterogeneous behavioral and economic reactions across different agricultural products.

Conclusion

In recent years, subsidy policies in the agricultural sector have played a significant role in farmers' production decisions and resource allocation. These policies have typically been implemented in the form of input subsidies, particularly for chemical fertilizers and fuel used in agricultural machinery, which covered a considerable share of farmers' variable production costs. However, due to the non-targeted nature of these subsidies and their lack of direct linkage to productivity or performance, they have in many cases led to suboptimal input use and the failure to achieve desirable economic and environmental outcomes. Therefore, examining the replacement of these policies with direct payments to farmers can be considered a potential solution for improving agricultural productivity and optimizing resource use. In this study, the main objective was to investigate the effects of replacing input subsidies with direct payments to farmers in the Dehgolan Plain of Kurdistan Province. In this study, direct payments were applied in two ways: first, as a direct cash transfer to farmers' income, which is included as an additive component independent of market prices in the gross profit function; and second, as a payment implemented through an effective adjustment of the output price received by farmers. The results showed that these two mechanisms have different effects on farmers' production decisions and cropping patterns. In the first case, direct payments have a direct effect on farmers' income, while in the second case, payments are incorporated into crop prices, leading to significant changes in cultivated area and gross income of different crops. In the first case, namely direct payments to farmers' income, it is observed that farmers have adjusted the cultivated area of certain crops in response to income changes. In particular, crops such as rainfed wheat and rainfed bean, which are more strongly affected by income fluctuations, experienced a reduction in cultivated area. This reduction can be attributed to the decline in relative profitability and economic returns of these crops compared to other cropping alternatives under the implementation of direct income payments. On the other hand, crops such as rainfed barley and alfalfa experienced an increase in gross income, leading to a larger share of cultivated area. This indicates that farmers tend to shift toward crops with higher economic returns and more efficient input use.

In the second case, namely direct payments based on product prices, similar results to the first case are observed, albeit with more pronounced changes. In this scenario, farmers show a stronger tendency toward crops such as irrigated wheat, irrigated bean, rainfed barley, and alfalfa. These crops experience a substantial increase in cultivated area, particularly irrigated bean and alfalfa, which record higher increases in scenarios with greater shares of direct payments. This expansion in cultivated area indicates the positive effect of direct payment policy through product prices, which enhances farmers' incentives to increase production. One notable finding of this study is the significant impact of direct payments on input use. In both direct payment schemes, input consumption, particularly water, nitrogen fertilizer, and potassium fertilizer, decreases. This reduction in input use, especially in higher payment scenarios, suggests that farmers respond to income and price changes by optimizing input allocation and reducing production costs. These changes can be considered a positive outcome in terms of improving agricultural efficiency and reducing negative environmental impacts. Therefore, these policies can effectively assist farmers in making better decisions regarding resource allocation and crop selection.

The findings of this study, in terms of both analytical framework and empirical results, are largely consistent with a number of studies on the substitution of input subsidies with direct payments (Vercammen, 2003). In the Dehgolan plain, this is reflected in changes in cropping patterns and the reallocation of cultivated area toward crops with higher economic returns. Furthermore, the results are consistent with two other studies highlighting the dual effects of input subsidies (Sane et al., 2021; Nguyen et al., 2023). Also, studies show that replacing fertilizer subsidies with direct payments leads to reduced chemical input use and changes in cropping patterns (Bakhshi et al., 2010; Bakhshi & Peykani, 2012). Finally, the findings are also consistent with studies conducted in Sub-Saharan Africa and Iran, which indicate that input subsidies do not necessarily lead to efficiency improvements due to issues such as substitution effects, leakage, and welfare costs (Jayne et al., 2013; Amadeh et al., 2014). Based on these findings, the present study confirms that direct payments, compared to input subsidies, can serve as a more efficient policy instrument for optimizing input use, guiding production decisions, and better aligning agricultural systems with productivity and sustainability objectives. However, these policies do not necessarily lead to a proportional increase in the gross income of all crops.

Based on the obtained results, it is recommended that the implementation of agricultural subsidy policies in the Dehgolan Plain be fundamentally reconsidered, taking into account the specific regional conditions. This revision can be carried out within the framework of national macro-level policies and with the aim of improving economic efficiency, enhancing resource allocation, and reducing pressure on local natural resources. In addition, given the structural similarity of the Dehgolan Plain to many agricultural regions of the country, the findings can serve as an empirical basis for designing and evaluating support policies in other regions with similar conditions, without conflicting with the national nature of subsidy policies. The first recommendation is that direct payments to farmers, particularly in scenarios with a higher share of price-based direct payments, be considered an effective instrument for stimulating the production of high return crops and increasing farmers' income. Furthermore, incorporating the specific characteristics of each crop and the economic conditions of farmers into the design of subsidy policies can contribute to improved agricultural productivity and sustainability. In addition, optimizing input use and reducing production costs through income based direct payment policies can help reduce environmental pressures and improve agricultural sustainability in the region.

Author Contribution

Authors contribution are as follows: Shiva Ramaei (50%), Hamed Najafi Alamdarlo (30%), and Mohammad Hasan Vakilpour (20%). All authors have approved the final version of the manuscript.

Data Availability Statement

The data that support the findings of this study are openly available at www.Trademap.org

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Ethical considerations

The study was approved by the Ethics Committee of the University of ABCD (Ethical code: IR.UT.RES.2024.500). The authors avoided data fabrication, falsification, plagiarism, and misconduct .

Conflict of interest

The author declares no conflict of interest.

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شیوا رمائی[۱] | حامد نجفی علمدارلو[۲] ✉ | محمدحسن وکیل‌پور[۳]

۱. گروه اقتصاد کشاورزی، دانشگاه تربیت مدرس، تهران، ایران. رایانامه: shiva.r.1397@modares.ac.ir

۲. نویسنده مسئول، دانشیار گروه اقتصادکشاورزی، دانشگاه تربیت مدرس، تهران، ایران. رایانامه: hamed_najafi@modares.ac.ir

۳. استادیار گروه اقتصادکشاورزی، دانشگاه تربیت مدرس، تهران، ایران. رایانامه: vakilpoormh@modares.ac.ir

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چکیده

دولت‌ها از طریق ابزارهای متعددی مانند یارانه‌های مستقیم، یارانه‌های نهاده‌ها، یارانه‌های صادراتی و سایر سیاست‌های حمایتی قادر به تأثیرگذاری بر میزان تولید و سطح زیرکشت محصولات کشاورزی هستند. این سیاست‌ها ممکن است منجر به تغییر الگوی کشت و بهبود درآمد کشاورزان شوند. در این مطالعه، با استفاده از مدل برنامه‌ریزی ریاضی اثباتی، آثار تغییر سیاست حمایتی دولت در قالب چهار سناریو، تداوم وضعیت موجود، حذف یارانه نهاده‌ها، اجرای پرداخت مستقیم به کشاورزان، و اجرای همزمان پرداخت مستقیم همراه با تغییر الگوی کشت، بر سودآوری و تخصیص منابع کشاورزی طی سال زراعی ۱۴۰۲-۱۴۰۳ بررسی شد. نتایج حاصل از اجرای سناریوهای مختلف سیاستی نشان می‌دهد که در واکنش به تغییر نظام حمایتی، سطح زیر کشت محصولاتی نظیر گندم آبی، نخود آبی، نخود دیم و جو دیم افزایش یافته است، در حالی که سطح زیر کشت گندم دیم، جو آبی، سیب‌زمینی، خیار، یونجه و پیاز کاهش را تجربه کرده است. این تغییرات حاکی از تعدیل الگوی کشت به سمت محصولاتی با بازده اقتصادی بالاتر، ریسک تولید کمتر و سازگاری بیشتر با محدودیت منابع و چارچوب سیاست پرداخت مستقیم است و نشان می‌دهد که تغییر سیاست حمایتی می‌تواند رفتار تولیدی کشاورزان را به سمت تخصیص کاراتر منابع هدایت کند. همچنین اعمال این سناریوها حاکی از کاهش مصرف نهاده¬های کود شیمیایی است که از نظر زیست‌محیطی دارای اهمیت است. همچنین، جایگزینی سیاست یارانه نهاده‌ها با سیاست پرداخت مستقیم، از منظر کارایی اقتصادی و پایداری زیست‌محیطی، رویکردی کارا و اثربخش محسوب می شود که ضمن حمایت از درآمد کشاورزان، از طریق کاهش مصرف کودهای شیمیایی، سموم و سوخت‌های فسیلی، به بهبود وضعیت محیط‌زیستی و ارتقای پایداری منابع طبیعی در منطقه مورد مطالعه منجر می‌شود.

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