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Agricultural Credit and Extension Services: Does Their Synergy Augment Farmers' Economic Outcomes?

Masaood Moahid [1,2], Ghulam Dastgir Khan [1,*], Yuichiro Yoshida [1,3,4], Niraj Prakash Joshi [3,5] and Keshav Lall Maharjan [3]

1 Graduate School for International Development and Cooperation, Hiroshima University, Higashihiroshima, Hiroshima 739-8529, Japan; masaoodnufa@gmail.com (M.M.); yuichiro@hiroshima-u.ac.jp (Y.Y.)
2 Faculty of Agriculture, Nangarhar University, Jalalabad, Nangarhar 2601, Afghanistan
3 International Economic Development Program, Graduate School of Humanities and Social Sciences, Hiroshima University, Higashihiroshima, Hiroshima 739-8529, Japan; nirajpj@hiroshima-u.ac.jp (N.P.J.); mkeshav@hiroshima-u.ac.jp (K.L.M.)
4 Network for Education and Research on Peace and Sustainability, Hiroshima University, Higashihiroshima, Hiroshima 739-8529, Japan
5 TAOYAKA Program, Hiroshima University, Higashihiroshima, Hiroshima 739-8529, Japan
* Correspondence: gdkhan.idec@gmail.com

Abstract: Access to credit is essential for sustainable agricultural development. This paper evaluates the impact of formal and informal agricultural credit, access to extension services, and different combinations of agricultural credit and extension services on the economic outcomes of farming households in Afghanistan. This study applies a quasi-experimental approach (propensity score matching) and inverse-probability-weighted regression adjustment (IPWRA) analysis. The data comes from a survey of 277 randomly selected farming households in the three districts of rural Afghanistan. The results show that having access to formal agricultural credit has a positive and differentiated impact on the farming costs and net revenue of farming households. However, the effects increase when a farming household has access to both formal credit and extension services. The results also reveal that credit constraints affect farming costs and net revenue. The study provides some practical implications for agricultural development policymakers. First, formal agricultural credit affects farm revenue in rural Afghanistan. Second, the impact of credit bundled with agricultural extension services on farm revenue is higher than the impact of the provision of each service separately. Therefore, a more sustainable agricultural credit arrangement should be supplemented by extension services for farmers in Afghanistan.

Keywords: formal agricultural credit; informal agricultural credit; PSM; IPWRA; net revenue; Afghanistan

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1. Introduction

Afghanistan's agriculture sector is marked by low productivity, mainly due to the limited application of improved inputs [1], subsistence farming, and low income [2]. Inadequate access to capital and a lack of farming skills are regarded as the primary causes of agricultural backwardness in the country [3]. Nevertheless, there is still a high potential for growth and increased income for farmers [2].

The use of farming inputs and technology is the core determinant that contributes to agricultural growth, which is usually restrained in developing and underdeveloped countries [4] because of the lack of household savings and the particular features of agriculture, such as the time lag between inputs and output. Therefore, access to credit, which is expected to positively affect farmers' resource allocation, is commonly considered to be a vital component of agricultural development. Access to credit is recognized as a means for overcoming farmers' capital constraints [5–9]. According to Saleem and Raouf [1], the low use of technologies due to a lack of capital and skills limits the sustainable development of agriculture in Afghanistan [1,10]. Credit is a vital facilitator for the sustainable

development of the farming sector [11]. Low access to capital is responsible for limiting farmers' productivity [12] and reducing income and investment [13]. It also affects the overall business performance [14] in rural areas in Afghanistan [15].

Considering this, the impact of agricultural credit has attracted considerable attention. Several studies have analyzed the effects of formal agricultural credit in developing countries (for instance, [5,8,9,16–22]). By employing diverse designs, most of these studies show that formal agricultural credit plays a critical role in transforming the agricultural production process by relieving capital constraints. Kumar et al. [8], for example, assess whether formal agricultural credit affects farmers' income and farm households' consumption expenditures. They find that access to formal agricultural credit significantly augments farmers' income. Jumpah et al. [19] suggest that a well-organized formal agricultural credit setting can meet farmers' needs and increase their productivity and revenue. They recommend expanding formal agricultural credit programs and policies, which can increase farmers' access to credit and meet farmers' needs.

Maia et al. [17] investigate the impact of credit access on farmers in Brazil. They find that credit access increases agricultural production. Furthermore, the impact is more substantial among poor farmers than among economically better-off farmers. Abdallah et al. [23] evaluate the impact of credit on the farmers of Ghana's savanna zones. They find that access to credit has a significant economic effect on agricultural households.

Formal-credit-using farmers include farmers who obtained credit from banking and non-banking formal financial institutions, such as commercial banks, microfinance institutions, credit unions, and other financial institutions (e.g., Agricultural Development Fund, Afghanistan). In acknowledging the importance of formal agricultural credit, the Afghan government and its donor partners have implemented many programs over the past two decades to expand access to formal credit in the country across different sectors, including farming. The formation of credit unions, microfinance, and other financial institutions and the development of commercial banking are examples of such programs. However, farmers' low access to credit continues to be a substantial predicament in the country. Credit provision to the farming sector is meager; according to the Agricultural Development Fund (ADF) [24], in 2017, the country's total supplied formal agricultural credit met only 4.71% of the total calculated demand for formal agricultural credit. Therefore, many farmers either remain cash-starved or depend on informal credit to purchase inputs for their farming activities. According to the National Risk and Vulnerability Assessment (NRVA) survey [25], 42% of Afghanistan's rural households depend on informal credit. Farmers acquire informal credit, such as personal credit, from relatives and friends, and transactional credit from various lenders, such as input suppliers and agricultural traders [26]. Furthermore, there is disagreement in the extant literature about the role of informal credit. Some studies reveal that informal credit is terrible for farmers' livelihood [27,28], while others verify its crucial function in economic development [29,30]. These contentions further intensify the generalization of the existing literature on informal credit to Afghanistan. Thus, it is also necessary to evaluate the effects of informal credit in the context of Afghanistan.

The results of the studies that examine the impact of credit are not all in one direction. For example, a very recent study by Nakano and Magezi [31] suggests that agricultural credit alone may be insufficient to increase agricultural productivity and income. Some researchers recommend the simultaneous provision of institutional services, such as formal agricultural credit, and agricultural extension services [32,33]. Bundling the abovementioned formal services for farmers may decrease technological and managerial obstacles. More specifically, agricultural credit provision may increase farmers' income by allowing them to procure and apply improved technologies [34]. Likewise, enhanced agricultural advisory services, which are provided through extension services, may lessen management gaps by training farmers in the use of new technologies and practices [35]. According to Ullah et al. (2020) [36], up-to-date information delivery to all farmers on farming systems and marketing linkages becomes increasingly essential. Agriculture extension is the means available to provide up-to-date information to farmers because the services aim

to improve farmland use, rural livelihoods, and well-being by enhancing information exchange. Therefore, this formal services arrangement may lead to sustainable agricultural development [10].

Farmers in Afghanistan have low skills in terms of using advanced technologies, improved inputs, and cultivation methods [3]. Furthermore, Afghan farmers' exposure to risk is high, while simultaneously, their productivity is low [24]. Kloeppinger-Todd and Sharma [32] argue that simultaneous access to both farm credit and advisory services increases productivity and mitigates farmers' vulnerability in developing countries. They also state that smallholder farmers in developing countries face problems accessing extension services, which are the key source of agricultural advisory services to the farmers. Therefore, formal agricultural credit provision becomes more effective when tied to extension services that provide agricultural advisory services. Makate et al. [33] suggest a simultaneous improvement in access to credit and extension services for the adoption of climate change adaptation technology among small farmers in Zimbabwe and Malawi.

In Afghanistan, extension services are provided by both the government and its donor partners. Extension staff of the Ministry of Agriculture, Irrigation, and Livestock deliver relevant agricultural advisory services to farmers in the city and district offices. In addition, large national programs, such as the National Horticultural and Livestock Program, Support to National Priority Program 2, Community Livestock and Agriculture Project, and Community-Based Agriculture and Rural Development, also aim to provide agricultural extension services across the country. Similar to access to credit, access to agricultural extension services is also meager in Afghanistan. According to Ahmadzai [37], only 22% of farmers in the country have access to formal agricultural extension services. Moahid et al. [9] and Sarhadi et al. [38] argue that agricultural extension services and education in Afghanistan can substantially affect the agricultural sector's sustainable development. However, some studies, such as Davidson and Ahmad [39], report that public and private agricultural extension service programs do not benefit farmers.

The studies, as reviewed above, are vital to explaining the importance of agricultural credit, extension services, and the simultaneous provision of credit and extension services. However, despite the considerable attention given to providing agricultural extension and credit services worldwide, there remains diversity in the conclusions about the impact of these services [40,41]. Additionally, it would be of great interest to analyze the impact of formal and informal agricultural credit interactions with agricultural extension services on a critical economic outcome, such as farm costs and net revenue. Thus, by using data from an agricultural household survey in rural Afghanistan, this study analyzes the impact of access to formal and informal agricultural credit, extension services, and their synergetic effects on farmers' net revenue and costs. This study also analyzes the impact of credit constraints on farmers' net revenue and costs. To attain the research objective, we apply propensity score matching (PSM), which removes self-selection bias from the impact assessment. To validate the PSM results, we use the inverse-probability-weighted-regression adjustment (IPWRA) approach.

This study contributes to the literature in two ways. First, we employ PSM and IPWRA to evaluate the synergetic impact of two critical agricultural services (i.e., agricultural credit and extension services) on farm costs and revenue. To the best of our knowledge, no empirical study using causal inference has estimated the synergetic impacts of agricultural credit and extension services on farm costs and revenue. Second, the existing studies are focused on countries with extended agricultural credit histories, while this study is unique in that it is the first to analyze the impacts of agricultural credit and related services on respondents who live in a hard-to-reach social context and in a country characterized as less experienced in formal agricultural credit intermediation. To collect data for this research, the survey was administered in rural areas of a country tormented by conflict and insecurity. According to Masaood and Maharjan [15], considering the coverage of formal agricultural credit and its short history, Afghanistan is less experienced in formal agricultural credit provision. It has not yet been established whether agricultural credit, its

synergy with agricultural extension services, and credit constraints affect farmers' costs and farm revenue in the context of Afghanistan.

The remainder of this paper is organized as follows. The second section includes the literature review. The third section discusses the data and the methods used. This section is followed by the results. The last section concludes the study.

2. Materials and Methods

2.1. Study Sites and Sampling

The data used in this study were collected through a household survey of farmers who participated in formal and informal agricultural credit programs and farmers who did not utilize any type of credit. First, we purposefully selected three districts (i.e., the Behsood, Paghman, and Balkh districts) located in Afghanistan's three regions. These three districts are categorized as rural areas and were chosen based on the accessibility of formal and informal credit. Farming is the primary source of the residents' livelihoods in all three districts [42]. Second, four or five villages in each district were randomly selected. Finally, 98 formal-credit-using, 99 informal-credit-using, and 105 non-credit-using farming households were randomly assigned to the sample, which resulted in a sample of 302 households. However, the data for this study are from 87 formal-credit-using, 94 informal-credit-using, and 96 non-credit-using farmers, for a total of 277 farmers; the remaining farmers were not included in the sample due to incomplete net revenue and cost data.

Furthermore, the net revenue values of only cereal crops and vegetables were considered. The treatment farming households are the formal- and informal-agricultural-credit-using households, which are defined as the households that obtained at least one loan between July 2016 and August 2018 for agricultural production. The control households are the households that did not use either formal or informal agricultural credit. In addition to formal and informal agricultural credit participation, this study also uses agricultural extension service participation and credit constraints as treatment variables. The household heads were interviewed face-to-face using a semi-structured questionnaire. In addition to the data related to credit and extension services, other socioeconomic characteristics, such as age, education, farming experience, crop diversity, household size, farm size, and education, were also gathered. The household heads were asked to report the details of income and costs from their last year's farming and nonfarming endeavors. Figure 1 shows the study area.

2.2. Variable Selection

This study selects various relevant explanatory variables that represent a farmer's pretreatment characteristics, following previous studies that have analyzed the determinants of agricultural credit services [9,33,43–46] and extension services [33].

Specifically, the household head's age, education, farming experience, farm expenditure, membership in a farmers' association, household size, dependency ratio, nonagricultural income, land collateral (having registered land documents), distance to a main city, raising livestock in addition to crops, crop diversity, and suffering from an economic shock in the past two years were used as explanatory variables. These variables are expected to affect agricultural credit, credit constraints, and access to extension services. The selected covariates are also expected to affect the outcome variable. Table 1 reveals and defines all of the abovementioned explanatory variables.

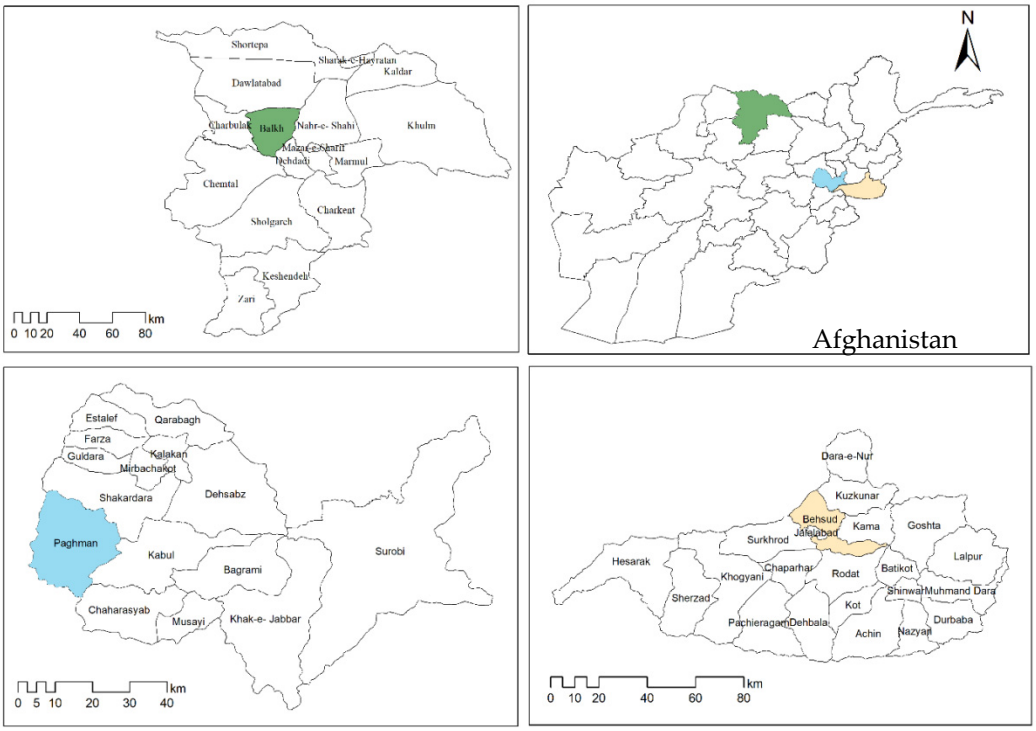

Figure 1. Study area. Source: Authors.

Table 1. Variable descriptions.

Variables	Description
Continuous	
Age	Years
Education	Years of formal education
Household size	Number of household members
Farm size	Size of cultivable land in jeribs *
Dependency ratio	Dependency ratio of a household
Crop diversity	Number of crops grown in the past year
Distance	Distance from the nearest city in km
Experience	Farming experience of the household head (years)
Discrete	
Nonagricultural income	1 = Households receive nonagricultural income 0 = Otherwise
Membership in association	1 = Membership in any farmers' association 0 = Otherwise
Registered land documents	1 = Have registered land documents that can work as collateral for obtaining credit 0 = Otherwise
Livestock	1 = Household raises animals in addition to crop production 0 = Otherwise
Income shock	1 = Household has faced crop failure, market failure, or any other unexpected loss in the last two years 0 = Otherwise
Treatment variables	
Access to any type of credit	1 = Household accessed formal or informal agricultural credit; 0 = Otherwise
Access to formal credit	1 = Household obtained formal agricultural credit; 0 = Otherwise
Access to informal credit	1 = Household accessed informal agricultural credit; 0 = Otherwise
Access to extension	1 = Household accessed agricultural extension services 0 = Otherwise

Table 1. *Cont.*

Variables	Description
Access to extension and formal credit	1 = Have accessed agricultural extension services and formal credit; 0 = Otherwise
Access to extension and informal credit	1 = Have accessed agricultural extension services and informal credit; 0 = Otherwise
Access to any type of credit and extension	1 = Have accessed agricultural extension and any type of credit; 0 = Otherwise
Credit constraints	1 = Credit-constrained household; 0 = Otherwise
Outcome variables	
Net revenue per jerib (AFN **)	Net revenue from vegetable and cereal crops in the last year
Input costs (AFN)	Total input costs per jerib in the last year
Labor costs (AFN)	Total labor costs per jerib in the last year
Total costs (AFN)	Total costs per jerib in the last year

* jerib = 0.2 ha; ** 1 USD = 69.30 AFN in September 2018.

2.3. Treatment Variables

This study's treatment variables are farmers' access to any type of credit, formal agricultural credit, informal agricultural credit, extension services, and a combination of extension services and agricultural credits (any type of credit, formal and informal) (Table 1). This study also examines the impact of credit constraints on farmers' net revenue. Credit-constrained farmers either acquire partial loans (less than they applied for) or do not acquire any amount. Thus, credit-constrained farming households constitute another treatment group for this study. This study's control group consists of noncredit-using farmers, farmers who did not access extension services, and credit-unconstrained farming households. Access to credit is marked as a binary variable in which "one" symbolizes that the farmers accessed some form of formal or informal credit for agricultural purposes in the preceding two years. Similarly, access to extension services is also a binary variable, with "one" indicating a farmer who accessed any type of agricultural extension services and "zero" indicating the opposite. In addition to assessing the effects of credit and extension services separately, this study also analyzes the effects of the simultaneous access to both extension and credit services. Thus, farmers who have used both services simultaneously in the two previous years are assigned "one", and farmers who did not receive either of these two services are assigned "zero". Likewise, a credit-constrained farming household takes the value of "one", and a credit-unconstrained household takes the value of "zero". Table 1 also describes all the treatment variables used in this study.

2.4. Outcome Variables

This study's outcome variables are the net revenue received by farmers from crop cultivation (vegetable and cereal crops) in the preceding year and costs for the same crops. The net revenue and costs were calculated based on the farmers' records. The net revenue was obtained after deducting the farmers' total costs incurred for crops grown from the total revenue received from these crops. Table 1 also describes the outcome variables used in this study. We examined the impacts of the treatment variables on the following three types of costs: input costs, labor costs, and total costs. Input costs exclude the labor costs and fixed costs incurred by farmers in the last year. Total costs include all variable and fixed costs, including the labor costs incurred by the interviewed farmers in the last year.

2.5. Data Analysis

This study first measures the effect of receiving agricultural credit on farmers' net revenue and costs in rural Afghanistan to verify that agricultural credit improves income by increasing the use of farming inputs. Formal or informal agricultural credit participation [10,43], credit constraint [46], and farmers' participation in extension services [33] is nonrandom. According to Lin et al. (2019), various socioeconomic characteristics influence credit constraint. Makate et al. [33] noted that socioeconomic characteristics of farmers affect extension services' participation. Therefore, simple linear regression models cause

endogeneity problems, which lead to biased results. The most reliable way to address such an issue is to employ an experimental study, such as a randomized control trial [31]. In randomized control studies, treatment and control groups are randomly assigned, and the potential confounding variables are equally distributed throughout the groups [47]. However, a randomized controlled trial requires interventions, which are costly and not always possible. Furthermore, an interventionist study's results may not be applicable in the long run. The extant literature has suggested various other methods to avoid selection bias. For instance, Rashid [48] uses the instrumental variable (IV) method. Nevertheless, coming up with a reliable IV is challenging for empirical studies.

In nonexperimental studies, the treatment is nonrandom [33,47]. In such cases, the potential observed and unobserved confounding variables may influence both the response and the treatment variables, which causes a selectivity bias dilemma. Many studies apply the matching method as a useful tool to relieve potential selection bias and endogeneity [33,49]. PSM imitates randomization while assigning the treatment [47] by matching the treated observations with the untreated observations. In this way, it imputes the unobserved counterfactual response variable by matching the treated observations with the closest untreated observations based on pretreatment features. Thus, initially, this study applies matching methods to determine the impact of agricultural credit on farmers' net revenue. The analysis in this study establishes that agricultural credit and extension services represent a treatment, where individuals using formal, informal, or any of the two agricultural credit types and the simultaneous users of agricultural credit and extension services represent the treatment groups, while the nonusers of these services are assigned as the control group. The average treatment effect on the treated (ATET) was taken as the measure of interest. This study uses multiple treatment PSM, of which the ATET is determined as follows:

$$ATET(x) = E[Y_1|D = 1, X = x] - E[Y_0|D = 1, X = x] \quad (1)$$

where X is a set of pretreatment characteristics, Y_1 is the potential outcome when treated, and Y_0 is the potential outcome when the unit is untreated; a condition that $D = 1$ limits to the units that are actually treated. Therefore $E[Y_1|D = 1, X = x]$ is the expected outcome (net revenue per unit of land) of the units that got treated that actually got treated, while $E[Y_0|D = 1, X = x]$ indicates the expected outcome of the units that got treated that were not treated. D is a treatment indicator for access to credit, extension, and their synergies.

To evade the selection bias issue, this study first measures the ATET through PSM. PSM assumes that the treated and untreated observations' potential systematic variations no longer exist after matching both groups' unobservable features [50].

The ATET through the propensity score P(x) under the main assumptions (i.e., conditional independence, independent and identically distributed observations, and the common support assumptions) are measured as follows:

$$ATET = E[Y_1|D = 1,\ P(x)] - E[Y_0|D = 1, \mathrm{P}(x)] \quad (2)$$

A sufficient overlap is expected between the control and treatment groups in the process of matching (i.e., common support). However, a low match problem occurs even if the overlap assumption is met. There may be a large gap between the two closest individuals' propensity scores available for the match, which causes poor matches. Therefore, in addition to using nearest neighbor matching and kernel matching, this study also applies the caliper restriction to mitigate this potential problem [47] by establishing a threshold for the maximum difference between the matched observations. If the difference is beyond the threshold, then the treated unit is omitted to avoid a biased estimation. This study adopts the frequently used caliper of 0.05.

Despite the benefits of the matching method discussed above, because of misspecification in the propensity score model, the ATET estimation from PSM may be biased [51,52]. PSM provides inconsistent estimates if the treatment model suffers from misspecification

bias. According to Imbens and Wooldridge [53] and Makate et al. [33], utilizing the IPWRA method solves this predicament. It utilizes weighted regression coefficients to measure the treatment level averages of the predicted results. The weights are the calculated inverse likelihoods of treatment.

IPWRA has a double robust characteristic, which provides consistent outcomes. It avoids misspecification bias by giving the response and treatment models to account for misspecification. Moreover, with IPWRA, if the treatment model is incorrectly specified, then the treatment effect estimates can still be consistent if the outcome model is not incorrectly specified. In addition, if the treatment model is not incorrectly specified, then IPWRA can provide consistent estimates, even when the outcome model is incorrectly specified. This is why IPWRA estimates are consistent with the presence of misspecification in the treatment or outcome model [53].

To calculate the treatment effects by applying IPWRA, this study measures the treatment model parameters and obtains inverse probability weights. We fit weighted regression outcome models for each treatment level and obtain the treatment-specific predicted results by employing the estimated inverse probability weights. Finally, the means of the treatment-specific expected results are estimated so that the contrasts of these averages deliver the estimates of the average treatment effects.

In addition to examining the effects of formal, informal, and any of these agricultural credits, this study also examines the synergetic impact of access to extension, access to agricultural credit services, and credit constraints on the economic measures of the interviewed agricultural households, specifically, net revenue and costs.

3. Results and Discussion

3.1. Descriptive Statistics

Tables A1 and A2 (See in Appendix A) compile and compare the interviewed households' descriptive statistics for credit and extension service access. Statistically significant differences between the covariates in the treatment and control groups imply the existence of the self-selection problem. Table A1 reveals that formal credit users have higher access than the other groups to extension services. They may be more connected to institutional services. However, this could also be because some financial institutions, such as the Agricultural Development Fund, connect farmers with extension service departments. Although most families are smallholders, the average farmland of the informal credit users is less than that of the other groups. The total land size is considered to be a vital determinant in household economic ventures. The formal credit users are also more educated (7.1 years) than the other groups. The literacy percentage is generally low in Afghanistan. In the entire sample, approximately 38% of the household heads never received any formal education.

The mean distance from the city for formal agricultural credit users was 9.9 km, while it was more for nonusers (12.55 km). The average agricultural experience of the nonuser household heads was 23.8 years, which was higher than that of the other groups. The percentage of households that obtained nonagricultural income was higher in the nonuser group (43%) than in the other groups. For nonuser households, agriculture may be less profitable because of their low investment. Thus, to help their families, they rely on off-farm ventures. Therefore, households with more extra income are less likely to borrow. However, this does not mean that credit access is easy for nonusers. Crop diversity was measured as the number of crops grown the prior year, which was lower for nonusers than for the other groups. For more details, refer to Table A1.

Table A2 reveals the interviewed households' descriptive statistics for access to extension services and the synergies of extension and credit services access. It shows that the group with simultaneous access to extension services and formal agricultural credit has more farmland than the other groups. However, the average age in the group with simultaneous access to extension and informal credit is higher, although the difference is statistically not significant. Among the credit users, the average education level is slightly higher for formal credit users than for the other groups. The household size is higher for

formal credit users than for the other groups. There is a significant difference between the average household size for credit users and that of the nonuser group. The household size difference between extension service users and nonusers is also significant. Similarly, among the credit users and nonusers, the difference in nonagricultural income is significant. Those who did not obtain any credit had a higher percentage of nonagricultural income. Likewise, the crop diversity of the farmers who did not have access to extension services was significantly lower than the crop diversity of the other groups, and it was higher among those who had access to extension services. This could be because the agricultural extension service providers in Afghanistan emphasize adding more crops (particularly high-value crops) to farmers' current crop mixtures. The average net revenue per jerib of the farmers who had simultaneous access to formal credit and extension services was higher than the net revenue of the other groups. The average net revenue per jerib was lower for those who did not access extension services than for the other groups (Table A2). The distributions of the outcome variables are depicted in Figure A1.

3.2. Determinants of the Treatment Variables

Table A3 presents the estimated coefficients of the logit models, which predict the treatment status. The estimated coefficients are interpreted as determinants that affect access to agricultural extension services, formal agricultural credit, informal agricultural credit, and simultaneous access to both credit and agricultural extension services. The baseline levels reflect no access to either agricultural extension services or any type of credit. The results indicate that farm size, membership in an association, and having registered land documents positively and significantly affect access to formal agricultural credit. Having registered land documents increases the probability of participation by 54.2%, which implies the importance of having land collateral. Household size also positively influences participation in formal agricultural credit, but only at a 10% significance level. Likewise, farm size positively and significantly influences formal agricultural credit. This finding agrees with the findings of [43], who also found that farm size influences credit access. Farmers with comparatively more farmland may have larger budgets for their planned farming activities, which increases their need for credit services. Moreover, a larger farm size increases the ability to diversify crops and produce high-value crops with access to credit. Age, distance from cities, and income shocks have adverse and significant effects on formal credit participation. When the household is located farther from the main city, it is less likely to obtain formal agricultural credit. This is because the offices of most formal financial institutions are in cities, and they prefer to have more proximal farmers as customers. In the case of informal credit users, farm size, receiving nonagricultural income, and rearing livestock have significantly negative effects on participation in informal agricultural credit. Farmers who receive income from sources other than agriculture may prefer not to access informal agricultural credit. Likewise, the farmers who raise livestock (e.g., cattle) may sell some of their animals when in need of cash. In addition, farmers who face income shocks are more likely to be granted informal credit, which implies a strong sense of cooperation in Afghanistan's rural areas [15]. Households that receive nonagricultural income and those with older heads of household had a lesser likelihood of access to all credit categories.

Farm size and membership in farmers' associations positively and significantly determine access to extension services, which influences farmers' decision to adopt innovation [54]. The effect of nonagricultural income is also positive and significant at the 10% level. The results for simultaneous access to both extension services and formal credit show that farm size, household size, and raising livestock mainly determine farmers' access to the abovementioned services. However, age, distance, and suffering from income shocks significantly and negatively influence simultaneous participation in formal agricultural credit and extension services. In the case of simultaneous access to both informal agricultural credit and extension services, rearing livestock along with crop production and

receiving nonagricultural income decrease the likelihood of participation, while income shocks positively and significantly increase the probability of participation.

Furthermore, the results show that access to both extension services and any credit type is positively and significantly affected by farm size, and negatively and significantly influenced by age and distance.

3.3. Impact of the Treatment Variables on Farmers' Net Revenue

Table 2 reveals the results of the PSM that shows the average treatment effects on treated (ATET) estimates, and explains how the net revenue per jerib changes because of treatment in the treated group. The PSM estimates are inferred regarding the possible outcome mean of the treated farmers if they were not treated. A positive ATET value implies an increase in the net revenue from the potential outcome, which would have happened if the farmers had no access to the services assigned as treatment variables (i.e., extension and credit). IPWRA was performed to evaluate the robustness of the main results on the impacts of formal agricultural credit, informal agricultural credit, agricultural extension services, credit constraints, and the combination of agricultural credits and extension services on net revenue. The IPWRA results along with results of the impact on input costs, labor costs, and total costs per jeribs are presented in Section 3.4 after the PSM estimates for concerned outcome variables namely, input costs, labor costs, and total costs per jeribs.

Table 2. Propensity score matching estimates (caliper, NNM, and kernel matching methods) of the net revenue per jerib.

Variables	Caliper		Nearest Neighbor Matching		Kernel		
	Net Revenue per Jerib (AFN)	T-stat	Net Revenue per Jerib (AFN)	T-stat	Net Revenue per Jerib (AFN)	T-Stat	Matches
	ATET		ATET		ATET		
Access to formal credit	4303.5 (1883.7)	2.2 **	4020.3 (2766.7)	1.4	4310.3 (1889.0)	2.2 **	87
Access to informal credit	−3216.3 (2111.53)	−1.55	−2186.3 (2289.5)	−0.9	−3259.1 (1688.9)	−1.9 *	95
Access to any type of credit	2496.7 (1894.0)	1.32	2697.2 (1751.8)	1.54	2426.1 (1920.6)	1.2	182
Access to extension	3357.0 (1626.7)	2.0 **	4489.1 (1869.3)	2.4 **	3609.7 (1642.7)	2.2 **	197
Access to extension and formal credit	5599.9 (2073.5)	2.7 ***	5862.9 (2279.1)	2.6 ***	5666.2 (2096.9)	2.7 ***	74
Access to extension and informal credit	−1817.1 (1869.39)	−0.99	−3485.49 (3010.1)	−1.16	−1793.5 (1837.8)	−0.9	54
Access to any type of credit and extension	4076.8 (1611.2)	2.5 **	2697.2 (1751.8)	1.5	4096.8 (1623.4)	2.5 **	128
Credit constraints	−4022.1 (2056.6)	−1.9 **	−8516.3 (3269.1)	−2.6 ***	−4504.5 (2137.2)	−2.1 **	203
N	277		277		277		

Note: ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. Robust standard errors are in parentheses.

Figure 2 depicts the sample's propensity score graphs. It shows the overlap in the propensity score range between the treatment and control groups. The distribution of the covariates among the control and treatment groups was not homogeneous. Nonetheless, after matching the propensity scores of the control and treated observations, the graph shows homogenous distributions of the propensity scores between the control and treated groups of the farmers in the sample (Figure 2).

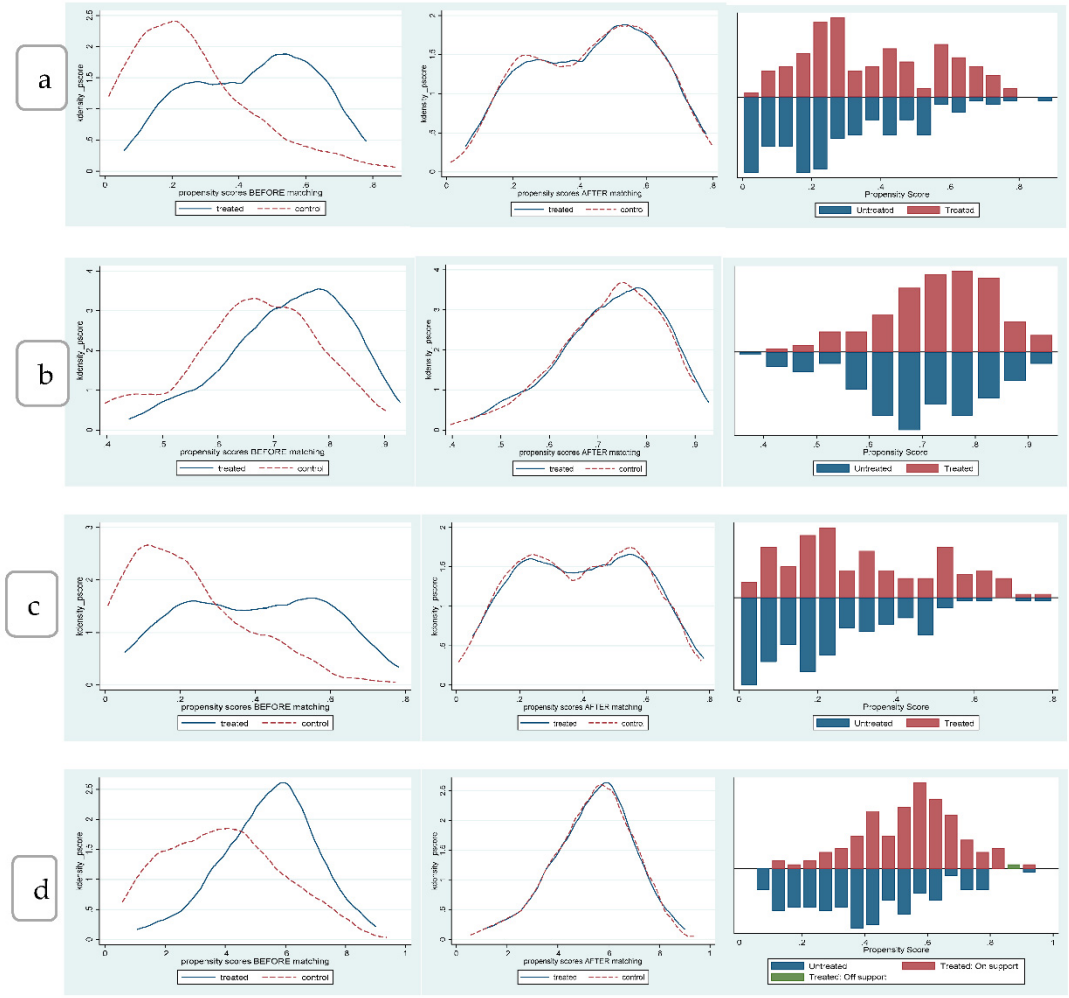

Figure 2. Propensity score graph before and after matching and overlap of the treated vs untreated groups of the formal credit user group (**a**), access to extension group (**b**), simultaneous access to formal agricultural credit and extension group (**c**), and any credit users and access to extension group (**d**).

The PSM results of all three algorithms, namely caliper, nearest neighbor matching (NNM), and kernel, reveal that the farmers' net revenue increases when they utilize formal agricultural credit. The net revenue difference values are AFN 4303.5, 4020.3, and 4310.3 per jerib in the caliper (0.05), NNM, and kernel matching, respectively. However, the difference in net revenue in the NNM matching algorithm is not significant. Furthermore, the propensity score graph of the formal credit users depicts overlaps in the propensity score range between the treatment and control groups (Figure 2).

In the informal credit group, PSM reveals that the farmers' net revenue declines when they utilize informal agricultural credit in all the matching algorithms. The net revenue difference values are AFN −3216.3, −2186.3, and −3259.1 in the caliper (0.05), NNM, and kernel matching estimations, respectively. However, the difference in net revenue is significant in only the kernel matching method. This could be due to the high costs and inadequacy of informal credit for farmers. According to Masaood and Maharjan [15], transactional informal agricultural credit has a much higher implicit interest rate. They also find that personal informal agricultural credit is too inadequate to have an impact in the rural areas of Afghanistan. The PSM results of the users of any type of credit show a positive difference in net revenue per jerib of land in the study sample. This study finds that in this category, the differences in net revenue are AFN 2496.7, 2697.2, and 2426.1 in the caliper (0.05), NNM, and kernel matching calculations, respectively. The results were not found to be significant in any of the matching estimations.

The farmers who accessed agricultural extension services received higher net revenue values than the farmers who did not. The net revenue difference values are AFN 3357.0, 4489.1, and 3609.7 in the caliper (0.05), NNM, and kernel matching calculations, respectively. The difference in the values in the NNM method was significant.

The farmers who simultaneously accessed both formal services (i.e., agricultural extension and formal agriculture credit services) received higher net revenue than the other farmers. The net revenue difference was much higher for these farmers than for the other groups. The net revenue difference was AFNs 5599.9, 5862.9, and 5666.2 in the caliper (0.05), NNM, and kernel matching calculations, respectively. The differences in net revenue in all the matching estimations were highly significant.

The results of the farmers who accessed both informal and extension services at the same time were not significant. However, simultaneous access to any type of credit and extension services positively impacts the farmers' net revenue. The results also show that credit constraints significantly decrease the farmers' net revenue (Table 2).

The IPWRA results also confirm that formal credit significantly increases the farmers' net revenue by 4482.6 AFN. In the case of informal credit users, the coefficient is not significant. Therefore, the informal credit results remain unclear in the study sample. Utilizing any type of credit in the study sample significantly augments the net revenue by 2591.1 AFN. Similar to the PSM results, access to extension services significantly increases the farmers' net revenue by 2751.0 AFN. However, it is significant only at the 10% level. The IPWRA estimation reinforces the PSM results in the case of simultaneous access to both formal agricultural credit and extension services that significantly impact farmers' revenue. The difference is also significant in economic terms, as the net revenue difference is the highest among all groups (5535.1 AFN). Finally, simultaneously accessing both extension services and any type of credit for agricultural purposes also significantly and positively affects the farmers' net revenue. Therefore, the most notable results of this study are that the synergetic effects of both formal agricultural credit and extension services are high. Separate access to formal agricultural credit and extension services also has an impact; however, it is inferior to accessing both. The impact of informal agricultural credit remains unclear.

3.4. Impact of the Treatment Variables on Costs

The impacts of the treatments on three types of costs (i.e., input, labor, and total costs) were individually analyzed. Table 3 reveals the PSM results for input costs. It shows the ATET estimates, which explain how the input costs per jerib change due to the treatment in the treated group. To evaluate the robustness of the results on the impact of the treatment variables on costs, IPWRA was also employed.

The PSM results of the three algorithms (i.e., caliper, NNM, and kernel) reveal that input costs per jerib increase when farmers utilize formal agricultural credit. The difference in input costs is significant in the caliper and kernel matching algorithm results. In the informal credit use group, the PSM results show that farmers' input costs decline; however, the result is not significant in any of the matching algorithms. The PSM results for any type of credit user show a positive difference in input costs per jerib of land in the study sample. The impact on the input costs of the farmers who received either agricultural extension services or both extension and formal agricultural credit services were positive but not significant in any of the matching algorithms.

The IPWRA results show that formal credit significantly increases farmers' input costs by 2794.13 AFN; for informal credit users, the coefficient is negative but not significant. Therefore, the informal credit results remain vague in the study sample. Utilizing any credit in the study sample significantly augments the input costs by approximately 1953 AFN. In contrast to the net revenue results, the impact on input costs of simultaneous access to both extension and formal credit is not statistically significant. However, it is positive except regarding access to extension services and informal credit. The results of the IPWRA show

that credit constraints have a significantly negative impact on the input costs and decrease them by AFN 1471.6 per jerib.

Table 3. Propensity score matching estimates (caliper, NNM, and kernel matching methods) of input costs per jerib.

Variables	Caliper		Nearest Neighbor Matching		Kernel		Matches
	Input Costs per Jerib (AFN)	T-Stat	Input Costs per Jerib (AFN)	T-Stat	Input Costs per Jerib (AFN)	T-Stat	
	ATET		ATET		ATET		
Access to formal credit	2666.03 (1315.86)	2.03 **	700.23 (1800.99)	0.39	2625.497 (1335.30)	1.97 **	57
Access to informal credit	−607.64 (1768.18)	−0.49	−442.57 (1795.75)	−0.25	−3421.081 (1813.24)	−1.09	
Access to any type of credit	2352.11 (1268.44)	1.85 **	2660.77 (1631.54)	1.61 *	2445.10 (1279.37)	1.91 **	53
Access to extension	−473.79 (1398.74)	−0.34	−2726.29 (1830.54)	−1.49	−649.65 (1414.68)	−0.46	51
Access to extension and formal credit	1679.59 (1326.78)	1.27	1740.20 (1426.53)	1.22	1746.40 (1323.00)	1.32	65
Access to extension and informal credit	−971.58 (1359.19)	−0.71	261.75 (1669.01)	0.16	−848.65 (1364.50)	−0.62	52
Access to any type of credit and extension	281.88 (1166.43)	0.24	2660.76 (1631.54)	1.63 *	335.37 (1173.28)	0.29	42
Credit constraints	−1554.21 (1092.97)	−1.42	−1518.59 (1383.47)	−1.10	−1702.74 (1116.66)	−1.52	66 54
N	277		277		277		

Note: **, and * denote significance at the 5%, and 10% levels, respectively. Robust standard errors are in parentheses.

Table 4 reveals the results of the PSM for labor costs. The ATET estimate in the table describes how the labor costs per jerib change because of the treatment in the treated group. The PSM results of the three algorithms (caliper, NNM, and kernel) reveal that labor costs per jerib increase when formal agricultural credit is utilized. The difference is highly significant in every type of algorithm.

In the informal credit group, the PSM labor cost results were not significant in any of the matching algorithms. The PSM results of access to any credit show a positive difference in the labor costs per jerib of land in the study sample, which is significant in all three algorithms but only at the 10% level. The labor costs of the farmers who received both extension and formal agricultural credit services were positive and significant in all three matching algorithms. However, unlike farmers' net revenue, the impact of credit on the labor costs does not increase when farmers access both extension and formal credit services simultaneously. A credit constraint significantly decreases the labor costs. The IPWRA results for the labor costs, in general, resemble the PSM results, which shows that using formal agricultural credit in the study sample significantly augments the labor costs by approximately AFN 1475. The agriculture sector in Afghanistan is not reliant on machinery and large equipment. The raising of crops primarily depends on human labor. Labor is required from the land preparation through the harvesting stage, and paying for agricultural labor is often a burden for farmers. Formal credit can increase farmers' ability to hire labor for their agricultural activities.

Table 5 reports the PSM results for the total costs per jerib of farmland in the study area. It shows the ATET estimates, which explain how the total costs per jerib change due to the treatment in the treated group. Similar to the other outcome variables, to assess the robustness of the results for the impacts of the treatment on total costs, the IPWRA estimation is also performed for the total cost outcome (Table 6). The PSM results of all three algorithms (caliper, NNM, and kernel) reveal that the total costs per jerib increase when farmers utilize formal agricultural credit. However, the difference is not statistically significant with the NNM matching algorithm.

In the informal credit group, the total cost PSM result is negative but not significant in any of the matching algorithms. The total costs of the farmers who received both extension and formal agricultural credit services are positive and significant in all three matching

algorithms. However, the results show that the impact of formal agricultural credit in isolation is higher (4107.8 in caliper) than the difference in total costs when farmers access both formal credit and extension services simultaneously. The IPWRA results for total costs show that receiving formal agricultural credit significantly increases the input costs by AFN 4269.6 (Table 6).

Table 4. Propensity score matching estimates (caliper, NNM, and kernel matching methods) of labor cost per jerib.

Variables	Caliper		Nearest Neighbor Matching		Kernel		Matches
	Labor Costs per Jerib (AFN)	T-Stat	Labor Costs per Jerib (AFN)	T-Stat	Labor Costs per Jerib (AFN)	T-Stat	
	ATET		ATET		ATET		
Access to formal credit	1441.81 ** (1273.32)	3.51 **	1922.98 (503.67)	3.82 **	1433.10 (418.45)	3.42 **	57
Access to informal credit	−618.18 (402.18)	−1.54	117.36 (615.41)	0.19	−496.26 (411.62)	−1.21	53
Access to any type of credit	729.82 (439.67)	1.66 *	1046.15 (527.27)	1.98 *	777.55 (442.20)	1.76 *	51
Access to extension	778.43 (426.39)	1.83 *	180.71 (527.78)	0.34	726.50 (431.04)	1.69 *	65
Access to extension and formal credit	1405.86 424.45	3.31 **	2024.32 (575.45)	3.52 **	1413.40 (423.28)	3.34 **	52
Access to extension and informal credit	−232.57 (441.06)	−0.53	−736.11 (641.19)	−1.15	−348.87 (437.80)	−0.80	42
Access to any type of credit and extension	1223.94 (372.98)	3.28 **	1046.15 (527.27)	1.98	1257.49 (375.11)	3.35 **	66
Credit constraints	−1174.22 (425.38)	−2.76 ***	−1293.84 (592.19)	−2.18 **	−1179.30 (436.34)	−2.70 ***	54
N	277		277		277		

Note: ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. Robust standard errors are in parentheses.

Table 5. Propensity score matching estimates (caliper, NNM, and kernel matching methods) of the total costs per jerib.

Variables	Caliper		Nearest Neighbor Matching		Kernel		Matches
	Total Costs per Jerib (AFN)	T-Stat	Total Costs per Jerib (AFN)	T-Stat	Total Costs per Jerib (AFN)	T-Stat	
	ATET		ATET		ATET		
Access to formal credit	4107.8 (1377.7)	2.9 **	2623.2 (1843.3)	1.4	4058.6 (1398.9)	2.9 **	57
Access to informal credit	−1225.8 (1311.8)	−0.9	−325.2 (1822.5)	−0.1	−1048.2 (1341.4)	−0.7	53
Access to any type of credit	3081.9 (1343.5)	2.2 **	3706.9 (1704.5)	2.1 **	3222.6 (1351.7)	2.3 **	51
Access to extension	304.6 (1492.3)	−0.2	−2545.5 (1918.7)	−1.3	76.8 (1509.3)	−0.1	65
Access to extension and formal credit	3085.4 (1407.2)	2.1 **	3764.5 (1597.4)	2.3 **	3159.8 (1170.49)	2.2 **	52
Access to extension and informal credit	−1204.1 (1426.5)	−0.8	−474.3 (1799.4)	−0.2	−1197.5 (1428.4)	−0.8	42
Access to any type of credit and extension	1505.8 (1238.2)	1.2	3706.9 (1704.5)	2.1 **	1592.8 (1245.4)	1.2	66
Credit constraints	−2728.4 (1238.9)	−2.2 **	−2812.4 (1684.4)	−1.6	−2882.0 (1267.9)	−2.2 **	54
N	277		277		277		57

Note: **, denote significance at the 5% level. Robust standard errors are in parentheses.

Table 6. IPWRA estimates for all output variables.

Variables	Net Revenue per Jerib (AFN)	z	Input Costs per Jerib (AFN)	z	Labor Costs per Jerib	z	Total Costs per Jerib	z
	ATET		ATET		ATET		ATET	
Access to formal credit	4482.6 (1294.8)	3.4 **	2794.13 (1145.81)	2.44 **	1475.49 (348.03)	4.24 ***	4269.6 (1176.5)	3.6 ***
Access to informal credit	−2593.8 (1375.06)	−1.8	−601.72 (1097.00)	−0.55	−193.18 (450.40)	−0.43	−794.9 (1245.6)	−0.6
Access to any type of credit	2591.1 (924.4)	2.8 ***	1953.83 (1211.90)	1.61 *	652.98 (459.99)	1.42	2606.8 (1178.0)	2.2 **
Access to extension	2751.0 (1608.9)	1.70 *	−266.21 (1099.07)	−0.24	798.45 (361.73)	2.21 **	532.2 (1162.9)	0.4
Access to extension and formal credit	5535.1 (1504.1)	3.6 ***	1489.98 (1085.73)	1.37	1591.25 (348.17)	4.57 ***	3081.2 (1142.7)	2.7 ***
Access to extension and informal credit	−661.6 (1232.9)	−0.5	−452.12 (1307.95)	−0.35	−86.04 (464.46)	−0.19	−538.1 (1409.4)	−0.3
Access to any type of credit and extension	4468.9 (1204.6)	3.6 **	1098.43 1195.63	0.92	1162.05 (364.06)	3.19 ***	2260.4 (1254.1)	1.5
Credit constraints	−3532.9	−1.8 *	−1471.62	−1.65 *	−1174.93	−3.43 ***	−2646.5	−2.6 ***
	(1944.1)		(892.93)		(342.70)		(993.1)	
N	277		277		277		277	

Note: ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. Robust standard errors are in parentheses.

According to Caliendo and Kopeinig [50], the primary purpose of PSM is to balance all decided covariates. Accordingly, we check the balance of the chosen covariates across the treatment groups. Tables A4 and A5 reveal the balance checking before and after matching. Overall, the balance is considerably increased after matching. There are statistically significant differences in age, household size, farm size, distance, income shock, and crop diversity before matching in the formal credit users and nonusers groups. Nevertheless, the differences become statistically insignificant after matching. The sizes of the differences are also lessened after matching. The balance checking of the simultaneous users of formal credit and extension services and nonusers of both services groups shows that the statistically significant difference in age, household size, farm size, distance, income shock, experience, and crop diversity become insignificant after matching (Table A5).

For a robustness check, the study estimated the impact of the treatment variables on the physical output. Wheat was the most common crop cultivated by approximately 83% of the farmers in the study area. The impact on output confirms the results of the impact of the treatment variables on farmers' net revenue. Using the NNM method, it was found that the impact of formal credit on output increases when the formal credit is bundled with extension services. The effect increases both statistically and economically. The IPWRA results confirm the PSM results. However, the results of the impact of access to informal credit and credit constraints are not significant (see Table A6).

4. Conclusions

This study attempts to identify the impact of agricultural credit (formal, informal, or any type of credit), extension services, and their synergistic effects on farmers' net revenue and costs in rural Afghanistan. It also analyzes the impact of credit constraints on the abovementioned outcomes. Using propensity score matching and an inverse-probability-weighted-regression adjustment analysis, it is found that simultaneous access to agricultural credit and extension services has a far more significant impact, both statistically and positively, on farmers' net revenue in the study sample. The impacts of formal credit or extension services in isolation are inferior. This may imply that formal agricultural credit enables farmers to procure and apply improved inputs, which, in turn, relieves technological obstacles, while access to agricultural extension services improves the managerial aspects of farming. Therefore, a side-by-side provision of these services has a more significant impact. The results for informal agricultural credit are unclear. It is also found that credit constraints significantly decrease farmers' net revenue.

The results also reveal that accessing formal credit increases the costs incurred by farmers. This impact was investigated on the following three types of costs: input costs, labor costs, and total costs. It is found that formal agricultural credit bundled with extension services significantly increases total costs, which implies more use of the inputs that contribute to high production. The impact is more pronounced in the case of labor costs. Furthermore, the results also show that credit constraints negatively impact all types of costs. Therefore, this study finds that access to formal credit has an impact on farmers in rural areas of Afghanistan. However, to have a greater impact, formal agricultural credit should be bundled with the extension services that farmers need.

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Institutional Review Board Statement: The research was approved by the Ethics Committee of Graduate School for International Development and Cooperation, Hiroshima University.

Informed Consent Statement: Informed consents were obtained from all respondents citing that the confidentiality of the response provided will be maintained strictly and no personally identifiable responses will be presented in the thesis or the research articles.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to ethical reason.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

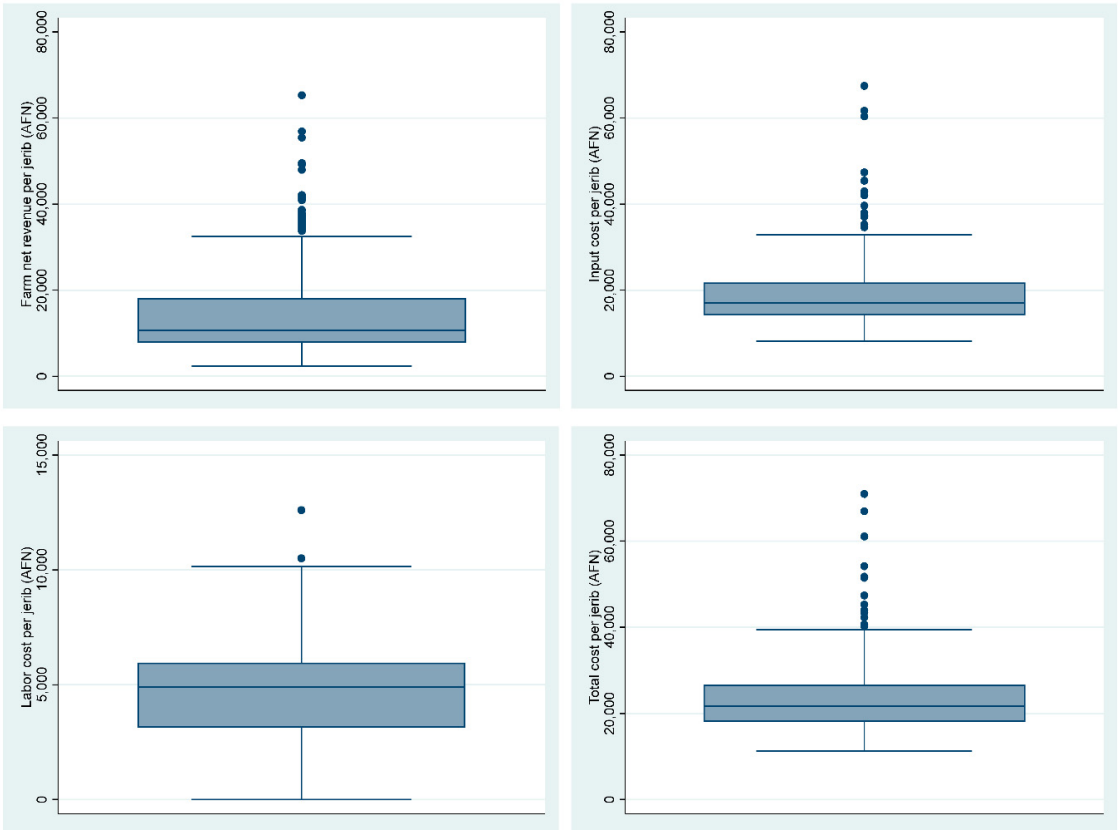

Figure A1. Box graphs of the outcome variables.

Table A1. Descriptive statistics of the variables by credit use.

Variables	All			Informal			Formal			Noncredit Users			ANOVA
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	*p*-Value
Access to extension (% access)	0.71 (0.45)	0.00	1.00	0.61 (0.50)	0.00	1.00	0.85 (0.36)	0.00	1.00	0.73 (0.45)	0.00	1.00	0.000 ***
Farm size (jeribs)	5.83 (4.30)	0.75	32.00	5.15 (3.35)	1.00	17.00	6.68 (4.39)	0.75	17.00	5.72 (4.93)	0.75	32.00	0.053 *
Age (years)	42.95 (13.29)	19.00	79.00	42.73 (12.33)	19.00	79.00	40.30 (12.05)	20.00	73.00	45.61 (14.83)	20.00	75.00	0.025 **
Education (years)	6.68 (5.85)	0.00	19.00	6.23 (5.77)	0.00	17.00	7.17 (5.97)	0.00	16.00	6.66 (5.83)	0.00	19.00	0.557
Household size	11.84 (5.00)	0.00	30.00	11.43 (5.26)	5.00	30.00	13.17 (5.37)	2.00	30.00	11.03 (4.11)	0.00	21.00	0.011 **
Dependency ratio	2.23 (1.44)	0.00	10.00	2.37 (1.76)	0.09	8.50	2.17 (1.18)	1.00	7.50	2.15 (1.29)	0.00	10.00	0.512
Nonagricultural income (% yes)	0.28 (0.45)	0.00	1.00	0.15 (0.36)	0.00	1.00	0.26 (0.44)	0.00	1.00	0.43 (0.50)	0.00	1.00	0.001 ***
Distance from city (km)	11.29 (3.91)	5.00	22.00	11.23 (3.60)	5.00	19.00	9.99 (3.58)	5.00	19.00	12.55 (4.13)	5.00	22.00	0.000 ***
Membership in farmers' association (% yes)	0.08 (0.27)	0.00	1.00	0.08 (0.28)	0.00	1.00	0.10 (0.31)	0.00	1.00	0.04 (0.20)	0.00	1.00	0.275
Registered land documents (% yes)	0.41 (0.49)	0.00	1.00	0.35 (0.48)	0.00	1.00	0.46 (0.50)	0.00	1.00	0.42 (0.50)	0.00	1.00	0.290
Farming experience (years)	22.55 (12.24)	5.00	65.00	22.36 (11.94)	5.00	50.00	21.28 (11.42)	5.00	50.00	23.89 (13.20)	5.00	65.00	0.349
Livestock (% yes)	0.73 (0.45)	0.00	1.00	0.67 (0.47)	0.00	1.00	0.74 (0.44)	0.00	1.00	0.78 (0.42)	0.00	1.00	0.260
Income shock (% yes)	0.20 (0.40)	0.00	1.00	0.29 (0.46)	0.00	1.00	0.10 (0.31)	0.00	1.00	0.19 (0.39)	0.00	1.00	0.005 ***
Crop diversity	0.43 (0.20)	0.00	1.00	0.45 (0.18)	0.00	1.00	0.50 (0.13)	0.00	0.76	0.34 (0.23)	0.00	0.69	0.001 ***
Net Revenue	15,775.71 (11,854.30)	555.56	75,460.00	15,222.30 (11,419.11)	3590.99	48,409.09	16,114.65 (14,133.05)	555.56	75460.00	16,018.73 (9949.28)	3304.00	39546.70	0.853
N		277			94			87				96	

Note: standard deviation in parentheses. ***, ** and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. A one-way ANOVA was utilized for the continuous variables. For the categorical variables, the Chi square test was used.

Table A2. Descriptive statistics of the variables by access to extension services.

Variables	Access to Extension and Formal Agricultural credit			No Access to Extension Services			Access to Extension and Informal Credit			Access to Any Type of Credit and Extension Services			ANOVA
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	*p*-Value
Farm size (jeribs)	6.82 (4.57)	0.75	17.00	4.99 (2.99)	1.00	12.00	5.50 (3.71)	1.00	17.00	6.17 (4.70)	0.75	32.00	0.038 **
Age (years)	39.14 (11.86)	20.00	73.00	42.79 (12.95)	20.00	75.00	44.22 (12.62)	19.00	79.00	43.02 (13.45)	19.00	79.00	0.895
Education (years)	6.93 (6.14)	0.00	16.00	7.24 (5.74)	0.00	16.00	5.76 (5.89)	0.00	17.00	6.45 (5.89)	0.00	19.00	0.308
Household size	13.65 (5.58)	2.00	30.00	11.21 (4.85)	0.00	30.00	11.48 (5.10)	5.00	30.00	12.10 (5.05)	2.00	30.00	0.098 *
Dependency ratio	2.22 (1.17)	1.00	7.50	2.15 (1.67)	0.14	8.50	2.33 (1.44)	0.09	6.00	2.26 (1.34)	0.00	10.00	0.568
Nonagricultural income (% yes)	0.30 (0.46)	0.00	1.00	0.21 (0.41)	0.00	1.00	0.19 (0.39)	0.00	1.00	0.31 (0.46)	0.00	1.00	0.100 *
Distance from the city (km)	9.96 (3.62)	5.00	19.00	11.28 (3.87)	5.00	22.00	11.22 (3.79)	5.00	19.00	11.30 (3.93)	5.00	19.00	0.962
Membership in farmers' association (% yes)	0.09 (0.29)	0.00	1.00	0.08 (0.27)	0.00	1.00	0.09 (0.29)	0.00	1.00	0.08 (0.27)	0.00	1.00	0.974
Registered land documents (% yes)	0.43 (0.50)	0.00	1.00	0.35 (0.48)	0.00	1.00	0.39 (0.49)	0.00	1.00	0.43 (0.50)	0.00	1.00	0.211
Farming experience (years)	20.28 (11.58)	5.00	50.00	22.25 (12.07)	5.00	55.00	24.20 (12.05)	5.00	50.00	22.66 (12.33)	5.00	65.00	0.798
Livestock (% yes)	0.74 (0.44)	0.00	1.00	0.71 (0.46)	0.00	1.00	0.61 (0.49)	0.00	1.00	0.74 (0.44)	0.00	1.00	0.689
Income shock (% yes)	0.11 (0.31)	0.00	1.00	0.24 (0.43)	0.00	1.00	0.30 (0.46)	0.00	1.00	0.18 (0.39)	0.00	1.00	0.300
Net revenue per jerib	17,471.12 (14,635.21)	3383.33	75,460.00	13,722.90 (10,962.78)	555.56	48,409.09	15,553.90 (10,819.98)	3590.99	42,926.28	16,609.34 (12,125.25)	3304.00	75,460.00	0.066 *
Crop diversity	0.50 (0.13)	0.00	0.76	0.38 (0.21)	0.00	1.00	0.49 (0.16)	0.00	0.83	0.45 (0.19)	0.00	0.83	0.050 **
N	74			79			54			128			

Note: standard deviation in parentheses. ** and * denote statistical significance at the 5%, and 10% levels, respectively. A one-way ANOVA was utilized for the continuous variables. For the categorical variables, the Chi square test was used.

Table A3. Determinants affecting access to agricultural credit and extension services.

Variables	Access to Agricultural Credit			Access to Agricultural Extension Services and Their Synergy with Agricultural Credit				
	Formal Credit	Informal Credit	Any Credit Type	Extension	Extension and Formal Credit	Extension and Informal Credit	Extension and Both Credit Types	Credit Constraint
Age	−0.045 **	0.000	−0.038 *	−0.004	−0.049 **	−0.006	−0.037 *	−0.001
	(0.022)	(0.021)	(0.021)	(0.020)	(0.023)	(0.024)	(0.019)	(0.021)
Education	0.035	−0.003	0.042	−0.028	0.011	−0.015	0.010	−0.047 *
	(0.027)	(0.026)	(0.027)	(0.026)	(0.029)	(0.030)	(0.024)	(0.027)
Farm size	0.066 *	−0.092 **	−0.021	0.084 **	0.063 *	−0.018	0.037 *	−0.017
	(0.036)	(0.039)	(0.035)	(0.040)	(0.037)	(0.042)	(0.032)	(0.036)
Household size	0.051 *	−0.016	0.035	0.015	0.079 **	−0.033	0.039	−0.009
	(0.031)	(0.030)	(0.032)	(0.030)	(0.032)	(0.035)	(0.028)	(0.031)
Dependency ratio	−0.056	0.076	0.059	0.041	−0.027	0.004	0.002	−0.082
	(0.113)	(0.095)	(0.105)	(0.103)	(0.116)	(0.112)	(0.094)	0.101
Nonagricultural income (% yes)	0.046	−1.369 ***	−1.154 ***	0.746 *	0.423	−0.692 *	−0.119	−0.123
	(0.335)	(0.357)	(0.313)	(0.334)	(0.348)	(0.404)	(0.297)	(0.332)
Distance from the city (km)	−0.179 ***	0.015	−0.129 *	0.002	−0.151 ***	0.003	−0.098 ***	0.120 **
	(0.044)	(0.037)	(0.038)	(0.037)	(0.046)	(0.043)	(0.036)	(0.044)
Membership in farmers' association	1.158 **	−0.039	1.116 *	0.191 *	0.915	0.207	0.767	−0.046
	(0.550)	(0.526)	(0.641)	(0.544)	(0.564)	(0.581)	(0.507)	(0.572)
Registered land documents	0.542 *	−0.407	0.088	0.381	0.317	−0.080	0.169	0.217
	(0.291)	(0.281)	(0.283)	(0.284)	(0.304)	(0.322)	(0.259)	(0.294)
Farming experience (years)	0.036	−0.004	0.028	0.003	0.024	0.020	0.030	−0.014
	(0.024)	(0.022)	(0.022)	(0.022)	(0.024)	(0.026)	(0.021)	(0.023)
Livestock	0.505	−0.528 *	−0.140	0.183	0.603 *	−0.764 **	−0.147	0.140
	(0.346)	(0.316)	(0.338)	(0.322)	(0.363)	(0.349)	(0.299)	(0.335)
Income shock	−1.113 **	0.911 **	0.193	−0.329	−1.013 **	0.765 **	−0.036	−0.801 **
	(0.427)	(0.330)	(0.354)	(0.335)	(0.450)	(0.366)	(0.322)	(0.339)
Crop diversity	0.327 **	0.334 **	0.271	0.220 *	0.322 **	0.443 **	0.521	0.092
	(0.133)	(0.121)	(1.035)	(0.120)	(0.132)	(0.144)	(0.971)	(0.130)
_cons	0.603	0.464	2.762 ***	0.029	0.160	−0.535	1.162	0.199
	(0.890)	(0.867)	(0.871)	(0.865)	(0.918)	(0.989)	(0.785)	(1.10)
Number of observations	277	277	277	277	277	277	277	277

Note: standard deviation in parentheses. ***, ** and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Credit-constrained and unconstrained farmers are defined following Awunyo-Vitor [40].

Table A4. Balance checking: formal credit users vs. informal credit users with nonusers.

Covariates	*Before Matching*				*After Matching*			
	Mean			***p*-Value**	**Mean**			***p*-Value**
	N	**Treated**	**Control**		**N**	**Treated**	**Control**	
Age	277	40.081	44.168	0.018 **	277	40.081	39.830	0.899
Education	277	7.069	6.447	0.412	277	7.069	7.145	0.933
Farm size	277	6.706	5.435	0.023 **	277	6.706	6.646	0.927
Household size	277	13.233	11.232	0.002 ***	277	13.233	12.913	0.695
Dependency ratio	277	2.186	2.257	0.703	277	2.186	2.006	0.354
Non-agricultural income	277	0.267	0.289	0.708	277	0.267	0.230	0.575
Distance	277	9.988	11.889	0.000 ***	277	9.988	10.360	0.474
Membership in associations	277	0.104	0.063	0.230	277	0.104	0.088	0.717
Registered land documents	277	0.465	0.384	0.207	277	0.465	0.509	0.565
Farming experience	277	21.170	23.126	0.221	277	21.170	21.393	0.907
Livestock	277	0.732	0.726	0.914	277	0.732	0.691	0.555
Income shock	277	0.104	0.242	0.008 ***	277	0.104	0.095	0.827
Crop diversity	277	3.872	3.247	0.000 ***	277	3.872	4.064	0.318

Source: Survey, 2018. Note: ** and *** represent statistical significance at the 5% and 1% levels, respectively.

Table A5. Balance checking: simultaneous users of formal credit and extension services vs non-users of both services.

Covariates	*Before Matching*				*After Matching*			
	Mean			*p*-Value	Mean			*p*-Value
	N	Treated	Control		N	Treated	Control	
Age	277	39.135	44.345	0.004 ***	277	39.135	39.077	0.978
Education	277	6.932	6.581	0.659	277	6.932	7.172	0.805
Farm size	277	6.821	5.464	0.020 **	277	6.821	6.745	0.916
Household size	277	13.649	11.182	0.000 ***	277	13.649	12.818	0.331
Dependency ratio	277	2.224	2.234	0.959	277	2.224	2.122	0.629
Non-agricultural income	277	0.297	0.276	0.727	277	0.297	0.228	0.340
Distance	277	9.960	11.778	0.001 ***	277	9.960	10.296	0.552
Membership in associations	277	0.095	0.069	0.478	277	0.095	0.105	0.835
Registered land documents	277	0.432	0.399	0.618	277	0.432	0.497	0.437
Farming experience	277	20.284	23.369	0.063 *	277	20.284	21.159	0.650
Livestock	277	0.743	0.724	0.753	277	0.743	0.765	0.759
Income shock	277	0.108	0.232	0.023 **	277	0.108	0.105	0.951
Crop diversity	277	3.892	3.286	0.001 ***	277	3.892	4.009	0.565

Source: Survey, 2018. Note: *, ** and *** represent statistical significance at the 10%, 5% and 1% levels, respectively.

Table A6. Propensity Score matching estimates (NNM method) and IPWRA of total wheat output per jerib (N = 232).

Variables	**PSM (NNM)**			**IPWRA**	
	Output per Jerib (Kg)	**T-Stat**	**Matches**	**Output per Jerib (Kg)**	**Z**
	ATET			**ATET**	
Access to formal credit	12.5 (8.2)	1.5	76	5.5 (9.8)	0.57
Access to informal credit	4.9 (7.9)	0.6	83	1.5 (7.2)	0.2
Access to extension and formal credit	16.8 (8.1)	2.1 **	65	20.8 (8.0)	2.6 **
Credit constraints	−2.8 (8.4)	−0.3	167	−2.0 (7.4)	−0.28

Note: ** denote significance at the 5% level. Robust standard errors are in parentheses.

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