Asian Journal of Agricultural Extension, Economics & Sociology
3(6): 605-618, 2014; Article no. AJAEES.2014.6.012

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Characterization of the Socioeconomic Conditions, Full Package, and Adoption of New Technologies of Wheat Crop at Irbid Governorate, Jordan

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Author's contribution

This whole work was carried out by the author MAH.

Original Research Article

Received 6th March 2014
Accepted 12th May 2014
Published 1st July 2014

ABSTRACT

The study explored socio economic conditions of wheat farmers to evaluate the impacts of the introduction of the full package(FP) which contains zero tillage, new varieties of wheat seed, adding fertilizer, using the combine, and using herbicides. Partial budget was used to work out the cost and returns of adopting the full package.

The principal method was the administration of a household questionnaire. The household questionnaire was designed to elicit basic numerical data on household structure, farm inputs and expenditures, crop production, wheat variety, farming method, and the strengths and opportunities of the new adopted technologies.

Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis was also used to provide a framework for potential solutions (opportunities) and threats, and analysis of the FP. Garrett ranking was applied to rank a set of factors in adopting the FP as perceived by the sample respondents based on certain criteria.

A socio-economic questionnaire was designed to elicit basic numerical data. About 50 farmers were personally interviewed in Irbid governorate.

Farmers were characterized by large number of family members and good education. The percentage of the male to female was nearly the same. Results showed that 48% of farmers have finished high school, and 34% have higher education.

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During 2012-2013 seasons, the participation of farmers in full package was very high. This is because adoption of improved crop management substantially increased farmer income. In other hands, the adoption of zero tillage is shown to increase steadily. Farmers started to gain awareness on the role of this system in achieving stability and higher profitability of wheat production. However, the adoption of this system could be further increased with the increase in availability of special driller's equipment and farmer learning. About 32% of the sample adopted the full package, and 22% adopted the new verities of seeds.
Garrett ranking showed that there are new techniques have been adopted by the farmers through the full package. Using seeders is one of the main newly adopted techniques as mentioned by 90% of farmers. Regarding to the use of improved variety, there were about 84% of farmers mentioned that they have planted the improved variety.

Keywords: Zero tillage; wheat production; new verities; garrett ranking; SWOT analysis.

1. INTRODUCTION

Jordan encourages wheat production through a price subsidy to producers. The amount of the subsidy is predefined each year prior to the cropping season. Nevertheless, farmers of rainfed are sequential decision-makers; they wait until they know the amount of rainfall between October 15th and the end of December to take a decision to plant wheat. Domestic wheat production has a very high degree of variability [1]. This instability of production makes it essential to introduce new techniques to enhance planting wheat.

The Project "Enhancing Food Security in Arab Countries" comes to enhance food security and focuses primarily on improving wheat production and yield in wheat-based agricultural systems. It introduced full package which contains zero tillage, new varieties of wheat seed, adding fertilizer, using the combine, and using herbicides.

It is important to demonstrate to farmers that the technical and agronomic aspects are directly related to the management and economic ones and, therefore, any technical and agronomic improvement obtained by using the full package need to be quantified in monetary and economic terms.

The determinants of new technology adoption are the benefits received by the user and the costs of adoption. In many cases these benefits are simply the difference in profits when a firm shifts from an older technology to a newer. In the case of farmers, of course, the benefits are the increased utility from the new technology.

Erensten, et al. [2] done a research about the adoption and impacts of zero-tillage in the rice wheat zone of irrigated Haryana. Results showed that the ZT-induced yield enhancement and cost savings provide a much needed boost to the returns to and competitiveness of wheat cultivation. The net revenue from ZT plots is significantly higher than that achieved in conventional plots.

Another research done by Tripathi and others [3], to compare the economics of wheat production in Haryana with zero tillage and conventional methods and assessed the contribution of technology and inputs to the increased productivity due to zero tillage (ZT). Results showed that the net income has been found higher in ZT method, mainly due to lower cost of production compared to that in conventional method. The study has observed

that ZT technology has potential to provide additional income to farmers and help in conservation of scarce resources.

The adoption of zero tillage improved soil fertility by reversing decades of soil degradation [4]. Zero tillage is an innovation package contains: management practices, herbicide, equipment (i.e., no-till drills and air seeder), and crop varieties, so the project introduced the full package to increase the income of farmers to enhance their livelihood.

Zero tillage innovation was introduced as an alternative to traditional tillage to combat soil degradation and to promote agricultural sustainability. The slow and lack of adoption of sustainable practices, especially in developing countries, call for additional research to better understand the local constraints to innovation adoption and to modify practices to better suit local conditions. In the case of zero tillage adoption, superior economic conditions, and social interactions allowed this technology to spread on the world [5] but only 4% of targeted farmers adopted zero tillage.

Yirga, [6], conducted a study in two woredas, Addis Alem and Wolmera of Ethiopia, to investigate the level of farmers' awareness and adoption of recommended and demonstrated technologies. The Probit and Tobit regression models were used for this study and the results indicated that the perceived profitability of the new wheat technologies and the timely availability of fertilizer and herbicide had the most significant effect on farmers' decisions to adopt. Distance of respondents' homes from extension centers also influenced the probability of adopting improved wheat variety, as well as the intensity of fertilizer and herbicide use. This suggests that improved production packages have been extensively diffused so that the knowledge of the benefits of using the new technologies is widespread. Moreover, extension efforts and input availability are most crucial in influencing adoption.

McMullan [7], wrote about IFPRI evaluation of a new wheat package rollout in Ethiopia and explained “what makes the package different is that it promotes optimal use of inputs and best agronomic practices to farmers.” The package includes recommendations for fertilizer application rates, use of certified improved seeds at a reduced seed rate, and planting in rows instead of scattering seeds by hand. Using a reduced-seed rate through row planting is a major piece of the package. However, farmers were convinced that 50kilograms of seed per hectare was not enough because they traditionally use 75kg per half hector.

This research comes for the purpose of socioeconomic characterization of the selected communities and to assess the adoption of the full package.

2. METHODOLOGY

A socio-economic survey was conducted to characterize the livelihood of farmers in term of their assets and opportunities. The study also explored socio economic conditions of farmers to evaluate the impacts of the full package. From the selected sites, 50 farmers were personally interviewed in Irbid governorate, namely in two districts, they are Bani kenanah, and Qasabet Irbid. Those farmers were the whole sample that is working with the project of “Enhancing Food Security in Arab Countries”.

Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis was also used to provide a framework for potential solutions (opportunities) and threats, and analysis of the full package (FP).

Garrett ranking was applied to rank a set of factors in adopting the FP as perceived by the sample respondents based on certain criteria. The order of the merit assigned by the respondents is converted into scores by using the formula given by Garrett and wood worth [8].

$$\text{Per cent position} = \frac{100\,(Rij - 0.5)}{Nj}$$

Where,

Rij = Rank given for Ith factor by j th individual
Nj = Number of factors ranked by ith individual

3. RESULTS AND DISCUSSION

3.1 Community Characterization

3.1.1 Climate

Jordan is part of Mediterranean and Arid zone climate. Mediterranean climate dominate in north and west regions, while arid climate dominates in the rest part of Jordan, whereas the semi humid climate is dominate in the selected areas and the rainfall ranged between 300-500mm [9].

3.1.2 Crop production

The major planted crops in the selected sites were barley, wheat, vetch, in addition to olive trees. Results shows that about 42% of the sample planted barley in addition to wheat, the average planted area is 6.6ha, and 20% planted vetch crop in addition to wheat, the average planted area is 3.5ha. Only 8% of farmers planted lentils in addition to wheat, the average planted area is 1.7ha.

3.1.3 Wheat variety

Farmers mentioned that they used to plant Hourani variety from early ago until nowadays because it is tolerant to drought as 23% of farmers mentioned, and it is available in the Jordanian Cooperative Corporation. About 32% mentioned that they plant this variety because it gives high production of seed and hay. About 57% of farmers plant Sham variety because it gives high production of seed and hay.

Previous research in Jordan proved that three varieties namely: Haurani 27, ACSAD 65 and Al-Samra could be considered as salt tolerant and accordingly they are suitable for durum wheat improvement. Furthermore, Sham 1 had the highest ability to germinate at high salinity level indicating that it has a genetic potential for salt tolerance [10].

Extension agents of the National Center for Agricultural Research and Extension (NCARE) provide farmers with improved varieties such as ACSAD, Dir-Alla, and they started to plant these varieties and they are now aware that these varieties give high productivity of seed and hay. About 74% plant ACSAD because it gives high production of seed and hay. About

67% of farmers plant Um-Qais because it gives high production of seed and hay. About 50% of farmers plant Dir-Alla because it is suitable to this area.

ACSAD variety gives the highest productivity of seed, and Hourani variety gives the highest productivity of hay. Previous research showed that also that ACSAD-176 produced the highest grain yield and that seems to be associated with higher number of kernels/spike [11].

Previous studies showed that yield increases (15–70%) have been achieved by resource-poor farmers over the existing varieties through the adoption of new varieties and new resource conservation technologies (RCTs). The farmers have also made substantial cost savings and achieved higher yields through resource-conserving agronomic techniques such as zero till [12].

3.1.4 Seeds sources and seed rate

The seed rate is different between farmers; some farmers add 120kg ha^{-1} of seeds as recommended by researchers and extension agents of NCARE, but the majority prefers to add 150-200kg ha^{-1} as their grand fathers did. The range was between 100-250kg ha^{-1}, the average quantity of seeds was 160kg ha^{-1}.

Previous research about seed rate proved that increasing seed rate from 25 kg/ha to 125 kg/ha will increase the wheat yield from 4081kg/ha to 5574kg/ha [13]. Although farmers continue to experience low yields in wheat production, research based results are promising with high more than 2.5-6tons per hectare are achievable if technologies were developed to increase wheat productivity through breeding of high yielding varieties and improved agronomic packages [14].

About 90% of farmers depend on the Jordanian Cooperative Corporation (JCC) to get seed, which costs US \$563 ton^{-1}, because it provides farmers with improved quality and guaranteed seeds as mentioned by 40% of farmers, and they purchase some local seed varieties from the other farmers as mentioned by 2% of farmers because it is tested. About 20% of farmers leave part of their production for seed purposes after succession in one season, and they also store a few amount of wheat production for home consumption.

Results of previous research about wheat seed production showed that farmers can save their own seed for planting for quite a long period of time once they have purchased seed of the new variety. Few farmers are willing to spend more money to purchase improved seed of wheat. On average, wheat farmers typically purchase a relatively small amount of improved seed [13].

3.2 Livelihood Characterization

3.2.1 Family Member

The average number of family was 9 members which indicated that it is a large family, and farmers like to increase the number of family members in order to help them in plant and livestock activities.

Farmer's age ranged from 30years to 84years with an average of 56years old. About 78% of farmers are less than 70years old, and 36% are from 30years to 49years old.

3.2.2 Educational Level

Regarding to farmer's educational level, results showed that 48% of farmers have finished high school, and 34% have higher education.

Regarding to son's educational level, results showed that 48% of males and 50% of females have finished higher education (Diploma, BsC, High education).

3.2.3 Number of male and female working in the farm

The farm activities were done mainly by men, about 74% of farmers mentioned that there is at least one male of the family members is working in the farm. Only about 26% of farmers mentioned that sons don't help in plant production, and about 64% of farmers mentioned that daughters don't help in plant production. The reason is because they are educated and they are not willing to work in agricultural activities or they are working in other jobs outside agricultural activities.

3.2.4 Role of Women in agriculture

Regarding to women participation, results showed that about 28% of women participated in plant activities, and 24% of them participated in milking and dairy processing activities.

3.3 Land Tenure

3.3.1 Land Ownership

Privately owned, rented, and partner land tenure were found in the surveyed community. Results showed that %76 of the respondents own land, the owned area is between 0.3ha and 22ha. About 48% of the respondents rent land, the rented area is between 1.5ha and 100 ha. About 8% of the respondents share land, the shared area is between 1 ha and 10 ha with an average of 4.0ha.

3.3.2 Crop Rotation

About 70% of respondents mentioned that they follow a double crop rotation, and 24% mentioned that they follow a triple crop rotation.

Previous studies proved that benefits of rotational cropping include breaking weed, disease and insect pest cycles; diversification to spread risk; different root systems to loosen compaction; possible nitrogen benefit from including a legume; and increased yields from the "rotation effect," even if the rotation does not include legumes. Including a summer annual that is not double-cropped also provides time between wheat harvest one year and planting the following spring, thus building up or banking soil moisture [15].

3.3.3 The previous crop before wheat

About 44% of farmers leave their lands without planting for one year before planting wheat, and 44% mentioned that they plant summer crops before planting wheat. Results of previous research indicated that large fields where corn was planted one year previous to wheat with minimum or no tillage had the highest values [16].

3.4 Farmer's Income Sources

The percentage of farmers who are depending on plant production source between (1-25 %) was 48%, and 44% are depending mainly on the off-farm income.

Regarding to credits, results showed that there are only 10% of farmers took loan from different sources. The average amount of the loan was US $2113.

3.5 Farmers' Practices

3.5.1 Farming method

There is about 32% of the sample adopted the full package, and 22% adopted the new verities, the rest are not participating in the project.

About 84% of farmers mentioned that they use seed driller for planting wheat, but 16% of farmers are still broadcasting their land by hand. Previous studies indicated that as much as 60% of the final yield potential for a wheat crop is determined at planting. Seeding too thinly, using poor quality seed, and uneven stands result in end of season yield losses that cannot usually be overcome [17].

About 80% of farmers mentioned that they plow their fields before planting wheat, but 20% of farmers mentioned that they use zero tillage.

Regarding to sowing date, farmers mentioned that they plant wheat during November and December each year after the first rainfall.

3.5.2 Labor

About 48% of farmers mentioned that they hired labor, but 52% mentioned that they don't hire labor because there is at least one member of the family is working in the farm.

3.5.3 Fertilizers

Farmers don't do soil analysis before adding fertilizers, 90% of farmers used to add manure and chemical fertilizer. Previous studies showed that fertilizer use can have substantial returns, even in the absence of any changes in other farming practices [18]. And the management practices that provide an adequate, but not excessive, supply of plant nutrients are essential for optimal yields of high quality winter wheat [19].

Only 4% of farmers added manure (organic) fertilizer and 70% of farmers added chemical fertilizers before agriculture as complex fertilizer in different ranges. And 14% of farmers added both organic and chemical fertilizers.

3.5.4 Weed control

The application of herbicides was done by 74% of farmers, and 26% of farmers mentioned that they don't apply herbicides because of the high cost of herbicides or because there are no weeds noticed in their fields.

Recent annual increases in wheat yields in Pakistan have been attributed to increased use of herbicides [20,21].

3.6 Garrett Ranking

Garrett ranking showed that there are new techniques have been adopted by the farmers. 90% of farmers mentioned that using seeders is one of the main newly adopted techniques for these reasons: good distribution of seed, profit increase with the increase in production, reduced seed rate, and saving in time and money (less number of workers).

Zero tillage is also one of the main newly adopted techniques as mentioned by 24% of farmers for these reasons: good distribution of seed, profit increase, and saving time and money (less number of workers).

Studies in India suggest that adopting farmers for zero tillage can boost their income by US$97 per hectare of land, and increase annual income by US$180 -$340. Zero tillage has increased wheat yields by 5-7% for Indian farmers [22,23].

86% of farmers mentioned that they add fertilizer for these reasons: profit increase, and it enhances the growth of the plant.

And 70% of farmers mentioned that they use herbicides for these reasons: profit increase, increase in the productivity, and weed reduction.

Weeds competition with wheat is a key point in yield reduction [24,25]. A considerable amount of research has been undertaken to estimate wheat production losses due to weeds. In 1997 it was estimated that the adoption of crop protection pesticides for controlling weeds, diseases and insects on wheat would increase Kazakhstan's wheat yield by an average of 0.15t/ha or 23% on average [26].

In the Ukraine in 1997, it was estimated that 13.6 million tons of wheat (27%) were lost due to weeds, insects and diseases: insects (8%), weeds (10.5%), and diseases (8.5%) [27].

On an average of three years post emergence herbicide applications increased wheat grain yield by 59, 64, and 67% as compared to the unweeded control, respectively [28]. Another research proved that the post emergence application of herbicides significantly increased the yield attributes as well as reduced the weed density [29].

Uncontrolled weeds have been identified as the main cause of low wheat yields in India and have been reported to reduce wheat yields by 25-30% [30].

Regarding to seeding rate, there are about 80% of farmers mentioned that they have reduced the seeding rate for these reasons: profit increase, and increase in the productivity.

76% of farmers mentioned that they adopted the use of fertilizer schedule for these reasons: profit increase, time and money saving, and increase in the growth of the plant.

Regarding to the use of improved variety, there are about 84% of farmers mentioned that they have planted the improved variety for these reasons: profit increase, increase in the productivity, and tolerant to water stress.

Only 14% of farmers used combine because it saves time and money, and increases the profit but it is not available at the requested time.

Garrett Ranking was applied also to rank the technologies according to its importance. Accordingly, the top priority was given by the respondents for seeder use, followed by others which are: adding fertilizer and fertilizer schedule, the using of herbicides, the use of improved variety, seed rate, combine, and the use of no-till seeder.

The use of the different techniques is easy and available according to farmers, but Ministry of Agriculture (MoA) and NCARE should enhance their role regarding to the awareness of farmers regarding the full package and its benefit.

3.7 Swot Analysis

The new adopted techniques save time as mentioned by all farmers, 92% of farmers pointed out that the new techniques allowed for planting earlier, and 90% of farmers mentioned that it reduced weed in their farms, 80% of farmers mentioned that the new techniques reduced the labor cost. About 49% of farmers mentioned that these techniques increased the production as well as the profit, and 56% of farmers increased the planting areas after launching the project.

About 68% of farmers mentioned that they are reluctant to apply the new technologies and methods because of the high cost, and about 60% of farmers mentioned that machines couldn't be available on time, and 66% said that there is difficulty in using these machines in sloppy areas. Only 20% of farmers complained that they don't have the improved variety.

About 23% of farmers mentioned that they would like to apply the new technologies and methods to increase the quantity and quality of production, and about 16% of farmers mentioned that there is opportunity to increase the planted area, and 9% said that using these machines will save time and effort.

About 43% of farmers mentioned that there is no problem in applying the new technologies and methods, but 22% said that they are reluctant to apply the new technologies and methods because machines couldn't be available on time and 9% said that there is difficulty in applying the new technologies and methods because of the raising in input prices (pesticides, fertilizers, seed). Box 1.

3.8 Marketing

Farmers mentioned that they have three marketing options; authorized marketing centers, intermediaries for sale, and personal marketing. About 33% of farmers take the role of marketing their production by themselves, because they can get direct financial benefits, easier for sale, and the farmer can decide the price and save the good quality for the next season. But 6% of farmers depend on Intermediaries for marketing their production because they can get direct financial benefits and easier for sale from their point of view.

About 61% of farmers depend on authorized marketing centers (Ministry of Trade and Industry, Jordanian Cooperative Corporation) for these reasons: easier for sale, and reduces the time and labor. But there are some problems face those farmers: seed examination, late payment for grains, and fluctuating prices.

Box 1. SWOT analysis for the full package

Strengths	Weaknesses
• Save time • Increase in production and profit • Reduce seed rate • Reduce the cost • Reduce weed • Reduce the labor cost • Increase planting area • Add fertilizer according to the quantity and type • Planting in suitable time	• Don't found machines at requested time • Don't have the improved variety • Difficulty use in sloppy areas • High prices of some technologies
Opportunities	**Threats**
• National Center for Agricultural Research and Extension • The private sector • Increasing in quantity and quality of production • The provision of manpower • Increase the area planted • keep up with technology • Cost Reduction • Increased income • The development of improved varieties • Reduce the seed rate	• Lack of mechanisms at the appropriate time • Raising input prices (pesticides, fertilizers, seed) • The high cost of manpower • Cost of pesticides and weed control • Lack of improved seeds • Higher prices of renting farmland

3.9 Costs and Returns of Wheat

The objective of this section is to estimate the costs and returns of wheat production after applying the full package. Data used for the analysis were collected through a well-structured questionnaire and personal interview on the plant units, costs and revenue items in the farm.

The net return for wheat enterprise is estimated at US $1105ha^{-1}, the increased in farmer income was come not only due to higher yields but also as a result of less inputs costs. The total variable costs are estimated at US $838ha^{-1} with total fixed cost at US $ 770ha^{-1}. The total cost of wheat is estimated at US $1608ha^{-1} and the total return is estimated at US $ 2394ha^{-1} (Table 1). The highest variable cost was the cost of labor followed by the cost of harvesting by combine. Regarding to the fixed cost, the cost of land rent was the highest followed by the cost of seed. As seed and fertilizer costs are a high percentage of revenue, management focus on these two items will pay good dividends. Land and machinery costs are also key cost items.

Table 1. Average net return and cost of production of wheat for one hectare

Activity	Unit	Quantity	Price US$	Total
Wheat grains	Kg	2500	0.563	1408
Straw	Kg	3500	0.282	987
Total Return	US$			2395
Variable Cost				837.1
Mechanical plowing	US$ ha^{-1}			74
Weeding	US$			14
Herbicides	US$			28
Pesticides	US$			14
Spraying Machine	US$			20
Fertilizer	Kg	100	0.98	98
Spreading	US$			11.8
Harvesting (by combine)	US$			119
Labor for Harvesting	US$			94.4
Urea	US$			73.8
Bags	no.	120	0.14	16.8
Transportation	US$			70
Labor	US$			126.8
Interest on operational cost				76
Fixed Cost	US$ ha^{-1}			769.6
Seeds	kg	169	0.56	94.6
Depreciation	US$			42
Land Rent	US$ ha^{-1}			563
Interest on capital cost	US$			70
Total Cost	US$			1606.7
Net return	US$			788.3

Source: Calculated by the researcher from the data of research sample

3.10 Wheat Cultivation Constraints and Suggestions

A question about what are the obstacles and difficulties in wheat cultivation, the answers were varied: limited access to machinery, erratic of rainfall, rising costs of production inputs, high labor wages, and land fragmentation.

Farmers suggested some ideas to solve these problems such as:

I. providing agriculture machines at encouraging prices,
II. governmental incentives and support for farmers,
III. providing farmers with improved varieties (tolerant drought),
IV. providing seeds at encouraging prices,
V. buying yield at encouraging prices,
VI. Activation of Agricultural Extension,

4. CONCLUSION AND RECOMMENDATION

The project disseminated to farmers new agricultural practices, technology, and high yielding varieties. The results show that transferring the new technology to all farmers is very important and will be very helpful in food security issues. For example, by implementing only the full package of integrated cropping practices in farmer's fields, wheat grain yield was

raised to more than 76% comparing with traditional methods. Not only the yield can be increased by the new technology but also the income of the farmers, this was obviously appeared when applying zero tillage.

In some demonstrations farmer income was increased to more than US $ 610 when applying zero tillage. The project introduces a number of improved varieties to the farmers in the target site. Availability of such varieties with good quantity among farmers will enhance the spread and adoption of these varieties and will add to the efforts of food security in the country.

The net return for wheat enterprise is estimated at US$ 788ha^{-1}, the total variable costs are estimated at US$ 837.1ha^{-1} with total fixed cost at US$ 769.6ha^{-1}. The total cost of wheat is estimated at US$1606.7ha^{-1} and the total return is estimated at US$ 2395ha^{-1}.
The highest variable cost was the cost of labor followed by the cost of harvesting by combine. Regarding to the fixed cost, the cost of land rent was the highest followed by the cost of seed.

The cost can be reduced through reducing seed rate, using the harvesting combine from the MoA instead of renting high cost private combines, and reducing the labor cost.

The recommended and promising technologies proved to be an appropriate and effective method that can be used in Jordan to increase both wheat yield and farmers income and therefore contribute to food security. Based on this study, it was shown that the farmers need support to continue farming their land successfully. The best way to support them is to provide them with the more practical incentives in the form of: improved varieties seed supply, accesses to machinery especially the zero till seeder, field learning of farming technology including herbicides for weed control. These incentives must be also combined with increasing the public awareness of the improved crop managements and varieties among the farming community and the stakeholders.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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