pISSN 1899-5241
eISSN 1899-5772

Journal of Agribusiness and Rural Development

www.jard.edu.pl

3(33) 2014, 283-297

FACTORS CONTRIBUTION TO THE ADOPTION OF PRODUCTION TECHNOLOGIES BY POTATO GROWERS IN NORTHWEST BANGLADESH

A.B.M. Sharif Uddin[1], M. Mostafizur Rahman[2], M. Bashirul Alam[3], M. Hasanul Kabir Kamaly[4]

[1]Zila Parishad, Natore
[2]University of Rajshahi
[3]Bangladesh Railway (West), Rajshahi
[4]Upazilla Agriculture Office, Tanore, Rajshahi

Abstract. The present study was undertaken to determine the factors which contribute to the adoption of potato production technologies by the growers. The adoption of potato production technologies by the growers was measured by computing of scores of proper land preparation, cultivation of modern variety, fertilizer dose, fertilizer application method, irrigation, plant protection measures, seed quality, intercultural operations, planting time, seed size and planting space. Data were collected from randomly selected 232 potato growers by using interview schedule in three Upazilla of Rajshahi district in Bangladesh during July 2010 to February 2011. Out of 11 technologies relating to the adoption of potato production, recommended irrigation was at the top of highest ranking by the adoption index and plant spacing was the lowest. Majority (46.55%) of the growers had medium adoption compared to high (29.74%) and low (23.71%) adoption. Pearson correlation test depicted that out of 22 variables, 16 had significant positive relationship with the adoption of potato production technologies. Results of stepwise multiple regression analysis revealed that seven variables namely: innovativeness, potato production knowledge, aspiration, potato problem awareness, group contact, peer relationship and attitude contributed significantly which altogether explained to the extent of 65.30% of the total variation to the adoption of potato production technologies. Path analysis indicated that these variables had both direct and indirect effects to the adoption behaviour. Potato growers who had more innovativeness, better knowledge in connection to potato produc-

Corresponding author – Adres do korespondencji: Md. Mostafizur Rahman, Professor, Department of Agronomy and Agricultural Extension, University of Rajshahi, Rajshahi-6205, Bangladesh, e-mail: mostafizur2001@yahoo.com

tion, more aspiration, more contact with group members, more peer relation and more favourable attitude were found to better adopt the potato production technologies.

Key words: adoption, production technologies, potato, factors contribution

INTRODUCTION

The economy of Bangladesh is agro based and agriculture contributes 20.60 percent of gross domestic product [BBS/DAE 2010]. Approximately 48.4 percent of its 144.2 million people directly or indirectly dependent on agriculture for subsistence [BES 2009]. Nearly seventy five (74.90) percent of country's population lives in rural areas [BBS 2010] and 48.4 percent of the country's total labour forces are engaged in agriculture. The comprehensive development of the country is largely dependent on the success of agriculture. The potato refers starchy tubers produced under soil from the crop plant *Solanum tuberosum* L. of the botanical family Solanaceae which is indigenous to the central Andean area of South America and originated in the high lands of South America. It ranks among the four most important food crops in the world including wheat, rice and corn [Netherlands catalogue... 2003]. People of at least 40 countries eat potato as their staple food [Islam 1993]. It is the third largest starchy food crop among the major food crops in Bangladesh commonly used as popular and important vegetables round the year. The soil and climatic condition of Bangladesh are very suitable for potato cultivation with mere chance of natural disasters unlike of *Kharip* seasonal crops. Potato takes only 90 to 115 days for maturity, early varieties of potato can be harvested after 75 days of plantation. Though production cost is high, farmers can easily draw profit through cultivation of potato. Net return from any other winter crop compared to potato is not exceeding. That is why potato has a greater contrast acceptance to the growers' level. Possibility of raising yield is far greater in potato than rice and wheat [Rashid 1987]. According to an estimate by Bhuiyan et al. [2002] the net cultivable land would be decreased from 8.42 million ha in 2000 to 7.89 million ha in 2025 and population would be increased from 127.22 million in 2000 to 168.89 million in 2025. Traditional methods of cultivation and other constraints which have negative influence on food availability over time. Potato cultivation has been getting popular in Bangladesh over last several years. Possibility of raising yield is greater in potato than rice and wheat. The soil and climate of Bangladesh is good enough to support potato yields more than 25 ton/ha but the actual yield is 15 ton/ha [Rashid 1987]. Adoption of potato technologies will increase production and thereby will improve the living standard of the farmers. The increased production of potato largely depends upon the farmers' feeling, thinking and knowledge i.e. psychological state of mind-perception and their appropriate adoption of high yielding modern variety production technologies. Again, either perception or adoption of technologies by an individual is influenced by his characteristics to a great extent. There are various characteristics of potato growers who actually act as farmers with their personal, social, economic and psychological behavioural patterns regarding potato production. Production performance is very much associated with adoption of production technologies Significant and insignificant relationship might be the exposure of adoption. But the extent of adoption influenced by characteristics and which technologies prevail forwards then others to the consideration of this study.

Keeping this view in mind, the present study was undertaken with the objective to identify the factors which contribute to the adoption of production technologies by potato growers.

MATERIALS AND METHODS

Study area, population and sample

The study was conducted in the Rajshahi district of northwest area of Bangladesh. Three Upazilla (administrative unit) namely, Mohonpur, Bagmara and Durgapur from this district were also selected considering their production performance and area coverage under potato cultivation. Finally, six villages from Mohonpur, 10 from Bagmara and four from Durgapur were selected randomly as a location of the study. Total number of potato growers who have at least 0.13 hectare of land for potato cultivation in these twenty villages was 1547 which constituted population of the study, 232 potato growers were selected randomly as the respondents covering 15 percent of the active population.

Data Collection and statistical analysis

Data were collected through personal interviews by using a structured interview schedule from July 2010 to February 2011. Necessary secondary data were also collected from different sources in addition to primary data. Descriptive statistical measures such as number, percentage distribution, range, mean, standard deviation and coefficient variation were used in describing the selected variables. To examine the relationship between the predicted and response variables, Perason's Product Moment Correlation Coefficient (r) was done. To ascertain the per cent contribution of a predict variable on the response variable full model and stepwise regression analyses were used. Path analysis technique was also used to interpret the cause effect relation.

Measurement of predicted (independent) variables

The predicted variables such as age, education, family education, family size and farm size were measured by using the measuring units of year, year of schooling, number of members and hectare respectively. The annual income was measured on the basis of total earning annually by all the members of the family and expressed in Taka. In order to know the agricultural knowledge, 25 questions covering the various aspects of agriculture. Full score (2) was assigned for each correct answer, 1 for partially correct answer and 0 (zero) for each wrong or no answer. Potato production knowledge of a respondent was measured by asking some questions covering the different aspects of potato cultivation. Total 10 questions contain several aspects with marking. Each question did not get the same score. It varied from four to six according to the nature and impact of the questions. The potato production knowledge scores could range from 0 to 50 while 0 for wrong or no answer. Total training experience was indicated by the number of days of training that a farmer had received during period of last year under differ-

ent agricultural training programs. A score of one (1) was assigned for each day of training received. For measuring the supervision of crop production, 15 statements were asked to indicate their opinion against four types of responses, such as 'frequently' 'sometimes' 'rarely' and 'not at all' the weights of 3, 2, 1 and 0, respectively. The range of the score was from 0 to 45 where 0 indicated no supervision and 45 indicated very high supervision. Peer relationship was determined according to the number of day contact made by the respondent with five selected peers in a week. Four measuring the psychological variables like attitude, aspiration and risk orientation, 5 point Likert type scale was used. A four point of awareness scale was prepared in this study for measuring potato production problem awareness of the farmers. Innovativeness, formal group affiliation, cosmopoliteness and extension media (individual, group and mass) contact were measured by as usual methods which are exiting in social science.

Measurement of response (dependent) variable

Based on available literature on the selection of potato production technologies [Muttaleb 1995, Hasan 2003, Farukh 2007], field visit and discussion with resource person of Department of Agricultural Extension (DAE), the researcher selected 11 technologies for studying in this investigation. These are (i) well land preparation, (ii) cultivation of modern variety, (iii) fertilizer dose, (iv) fertilizer application method, (v) irrigation, (vi) plant protection measures, (vii) quality seed, (viii) inter cultural operations, (ix) planting time, (x) seed size and (xi) planting space. Procedure for computing score for adoption of each of the eleven technologies and the score for overall adoption of the eleven technologies are described as follows:

Good land preparation. Ploughing depth and smoothness of cultured soil provide predisposition for potato cultivation. Land preparation score could range from 0 to 6, where 0 indicated non adoption of good ground preparation and 6 indicated high adoption of proper land preparation.

Modern variety cultivation score. If the modern variety potato cultivated area covers up to 10% of the total cultivated area could score 01 and at every 10% more area add one sub-score ultimately highest sub-score ranges 10. Time sub-score was computed by using continuous cultivation practice as 1, 2, 3, 4 for the number of years and 5 for continuous cultivation practice up to 5 years or more. Thus the scores could range from 1-15 where 1 indicated lowest adoption and 15 indicated highest adoption of modern varieties potato cultivation.

Fertilizer dose. Fertilizer score is consisted of combined scores of recommended or over six fertilizers dose score of Urea, Triple Super Phosphate (TSP), Muriate of Potash (MP), Gypsum, Zinc Sulphate and cowdung and scored as 4, 3, 2 and 1 for recommended dose. Also 0, 1, 2 and 3 for double, three-fourths, half, or quarter for the over dose respectively. So, six fertilizer full dose scored 6 by 4 = 24 and double dose scored 6 by 0 = 0. The score could range from 0-24.

Fertilizer application method. As Tuber Crops Research Center recommends thus the basal dose as applied by Before land preparation (broadcast), At the time of final land preparation (broadcast) or in fertilizer furrows scored as 0, 1 and 2 and later dose application for not used, Top dressing and side dressing/spraying (for Zinc fertilizer) scored as 0, 1 and 2. Thus the score could range from 0-4.

Irrigation. Irrigation score of a respondent was computed on the basis of the number like no irrigation, one time irrigation, 2 times irrigation, 3 times irrigation and 4 or more times irrigation with the corresponding score of 0, 1, 2, 3 and 4 respectively.

Plant protection measures. Tuber crop research centre recommended six types of plant protection like seed treatment, soil treatment, insect control, disease control, seed sorting, and suberization. In addition proper care of aeration and light for the potato fields and stores of tuber seeds was considered as a way of prevention of seed quality control, against the extent of measurement as no treatment, occasional treatment and necessarily treatment with marking of 0, 1 and 2 accordingly. The seven sub-scores as told above collectively constituted the plant protection score. Each of the seven sub-scores could range from 0 to 2. Therefore, the plant protection score could range from 0 to 14, where 0 indicated no adoption and 14 indicated highest adoption.

Use of quality seed. Score were assigned for certified or Bangladesh Agricultural Development Corporation seeds, self produced/own seeds, collected from fellow farmer's seed, seed from other nearest sources and seed collected from unknown person or open market weighed as 5, 3, 2, 1 and 0 accordingly. Thus Seed score could range from 0 to 5, where 0 indicated non adoption of quality seed and 5 indicated high adoption.

Intercultural operation. A list of intercultural operations as weed control, mulching, roughing, removal of virus affected plant, breaking of soil clots, rodent control and earthing up were assigned as of plant protection measures with corresponding extent of measurement of nature of action taken as no, occasional and according to necessity and weighed as o, 1 and 2 respectively

Planting time. The scale used for computing the planting time score as last week of October to mid November, mid November to November and after November as scored of 0, 1 and 2 respectively and where 0 indicated non adoption of optimum planting time and 2 indicated high adoption.

Seed size score According to the recommendation of potato scientists, the following scale of tuber cut into 2 pieces, tuber cut into 3 to 4 pieces and tuber cut into more than 4 pieces weighed as 2, 1 and 0. Seed size score could range from 0 to 2, where 0 indicated non adoption of appropriate seed size and 2 indicated high adoption.

Planting space. Spacing score consisted of two sub-scores, namely line to line sub-score 23-24 inch, 20-22 inch and less than 20 inch scored as 2, 1 and 0; and plant to plant sub-score 5-6, 3-4 and less than 3 inch weighed as 2, 1 and 0. Spacing score was obtained by adding its two sub-scores as told above. Each of the two sub-scores could range from 0 to 2. Therefore, spacing scores of the respondents could range 0 to 4, where 0 indicated non-adoption of recommended spacing and 4 indicated high adoption.

Overall adoption score of all technologies. Thus the overall scores of adoption of potato production technologies could range from 1-94 (Table 1), where 1 indicated at the bottom of adoption and 94 remarked for peak of adoption. But this range of adoption definitely found higher than 1 and below from 94 which was real calculated range for measuring actual elasticity of adoption. And there by, the elasticity was categorized as low, medium and high according to their range of score distribution as found as minimum to maximum level.

Table 1. Scoring system of adoption technologies
Tabela 1. System punktowego oznaczania zastosowanych technologii

No Numer	Item of technologies Elementy zastosowanych technologii	Range of scores Zakres punktów
1	Proper land preparation Właściwe przygotowanie ziemi	0-6
2	Cultivation of modern variety Uprawa nowych odmian	1-15
3	Fertilizer dose Stosowana dawka nawozów	0-24
4	Fertilizer application method Sposób stosowania nawozów	0-4
5	Irrigation Nawadnianie	0-4
6	Plant protection measures Środki ochrony roślin	0-14
7	Use of quality seed Zastosowanie ziarna kwalifikowanego	0-5
8	Intercultural operations. Techniki zmienno-gatunkowe	0-14
9	Planting time Data sadzenia	0-2
10	Seed size Wielkość ziarna	0-2
11	Planting space Odległości między rzędami	0-4
	Total 11 technologies Łącznie 11 technologii	1-94

MEASUREMENT OF COMPARATIVE ADOPTION OF ELEVEN SELECTED PRODUCTION TECHNOLOGIES OF POTATO PRODUCTION

For comparing the extent of adoption of all selected technologies as a factor of adoption determinants it was required to compute an adoption index for each of the eleven technologies. The adoption index for a certain technology was computed by using the following formula:

$$\text{Adoption index} = Pn \times 0 + Pl \times 1 + Pm \times 2 + Ph \times 3$$

where: Pn – Percentage of farmers having no adoption,
Pl – Percentage of farmers having low adoption,
Pm – Percentage of farmers having medium adoption,
Ph – Percentage of farmers having high adoption.

Adoption index of a technology could be range from 0 to 300, where 0 indicates no adoption and 300 for maximum adoption.

RESULTS AND DISCUSSION

The eleven modern technologies have been arranged in rank order on the basis of their adoption indices in Table 2. Analysis of data in Table 2 indicates that among the extent of adoption of modern eleven technologies recommended irrigation was at top highest ranking by the adoption index of 261. Muttaleb [1995] also found the similar findings in his study. The adoption index of well land preparation, use of quality seed, modern variety cultivation, fertilizer application method, inter cultural operations, plant protection measures were 234, 227, 222, 221, 218 and 201 respectively. But below two-thirds of adoption index scores were found in planting time, fertilizer doze, seed size and plant spacing 200, 190, 146 and 140 respectively.

Table 2. Ranking order of modern variety potato production technologies
Tabela 2. Uszeregowanie zastosowanych technologii w zakresie wykorzystania nowych odmian ziemniaków

Step No. Krok	Modern technologies Nowe technologie	Adoption index Wskaźnik zastosowania	Rank order Kolejność w rankingu
1	Proper land preparation Właściwe przygotowanie ziemi	234	2
2	Cultivation of modern variety Uprawa nowej odmiany	222	4
3	Fertilizer dose Dawka nawozu	190	9
4	Fertilizer application method Metoda stosowania nawozu	221	5
5	Optimum irrigation Optymalne nawodnienie	261	1
6	Plant protection measures Środki ochrony roślin	201	7
7	Use of quality seed Zastosowanie nasion kwalifikowanych	227	3
8	Intercultural operations Techniki zmienno-gatunkowe	218	6
9	Planting time Data sadzenia	200	8
10	Seed size Wielkość ziarna	146	10
11	Planting spacing Odległości między rzędami	140	11

Source: own calculations from field data.
Źródło: obliczenia własne na podstawie danych z badań terenowych.

Adoption of seed size and plant spacing were at lowest ranking. Seed size of lowest ranking also observed by Muttaleb [1995]. From the above findings, it is evident that the comparative priority in adoption of quality seed is considered by the farmers but might be due to unconsciously optimum seed size is still ignored. Fertilizer application method is more adopted than fertilizer doze indicated farmers' exposure among them is better but doze selection would have been going on as self-centered pre-conceived idea of fertilizer use or lack of knowledge about nutrient contents in fertilizer and manures.

OVERALL ADOPTION OF MODERN POTATO PRODUCTION TECHNOLOGIES

In order to have a clear understanding of the combined adoption of the eleven selected potato production technologies, an overall adoption score was computed for each of the respondent by adding the score of 11 modern potato production technologies. Possible range of the overall adoption score of the study respondent farmers could range from 1 to 96, where 1 indicated minimum adoption and 96 indicated maximum adoption of potato production technologies. Computed overall adoption scores of the farmers ranged from 45 to 80.50. The mean value is being 63.32 with standard deviation and co-efficient of variation 7.92 and 62.70 respectively. Based on the observed scores, potato grower farmers were classified into three categories such as 'low' adoption, 'medium' adoption and 'high' adoption as shown in Table 3.

Table 3. Distribution of the farmers according to their overall adoption of modern potato technologies

Tabela 3. Rozmieszczenie przestrzenne rolników w oparciu o zastosowane przez nich nowoczesne technologie uprawy ziemniaków

Categories according to overall adoption (scores) Kategorie w oparciu o całkowite dane dotyczące zastosowanych technologii (punktacja)	Potato growers		Mean Średnia	Standard deviation Odchylenie standardowe	Co-efficient of variation Współczynnik zmienności
	number ilość	percentage procent			
Low adoption (45-57) Niski stopień zastosowania (45-57)	55	23.71	63.32	7.92	62.70
Medium adoption (57.01-68.83) Średni stopień zastosowania (57.01-68.83)	116	50.00			
High adoption (68.84-80.50) Wysoki stopień zastosowania (68.84-80.50)	61	26.29			
Total Łącznie	232	100			

Source: own calculations from field data.
Źródło: obliczenia własne na podstawie danych z badań terenowych.

Data contained in Table 3 indicates that majority (46.55%) had medium adoption compared to high (29.74%) and low (23.71%) adoption. But almost three-fourths

(73.71%) of the farmers had low or medium adoption. Potato as a short duration starchy vegetable crop might have scope of alternative source of staple food would play a significant role in meeting the increasing demand of rice and wheat grain.

VARIABLE RELATED TO ADOPTION OF POTATO PRODUCTION TECHNOLOGIES

A total of 22 selected characteristics of the potato growers were considered as predict variables in this study. In order to test the relationship of these characteristics to adoption of potato production technologies was computed. The computed correlation coefficients are shown in the Table 4.

Table 4. Coefficient of correlation between the selected characteristics of potato growers and their adoption of potato production technologies

Tabela 4. Współczynnik korelacji między wybranymi cechami plantatorów ziemniaków a zastosowaniem różnych technologii produkcji

Predicted variables (farmers' selected characteristics) Przewidywane zmienne (wybrane cechy rolników)	Response variable Zmienna odpowiedzi	Observed 'r' value Zanotowana wartość 'r'	Tabulated values with (N-232) d.f. at 230 Stablicowane wartości (N-232) ze współczynnikiem równoczesności na poziomie 23.0	
			0.05 level poziom 0,05	0.01 level poziom 0,01
1	2	3	4	5
Age Wiek		0.012^{NS}		
Education Wykształcenie		0.153*		
Family size Wielkość rodziny		0.044^{NS}		
Family education Wykształcenie członków rodziny		0.129^{NS}		
Training experience Doświadczenie z zakresu doskonalenia zawodowego		0.284**		
Crop production supervision Nadzór nad uprawami		0.140*		
Agricultural knowledge Wiedza rolnicza		0.222**		
Potato production knowledge Wiedza z zakresu produkcji ziemniaków		0.509**		
Innovativeness Innowacyjność		0.695**		

Table 4 – cont. / Tabela 4 – cd.

1	2	3	4	5
Farm size Wielkość gospodarstwa		0.115 NS		
Annual income Dochód roczny		0.203**		
Formal group affiliation Przynależność do grup formalnych		–0.027 NS		
Cosmopoliteness Postawa kosmopolityczna	adoption	0.173**	0.130	0.171
Extension media contact Kontakt z ośrodkami upowszechniania wiedzy rolniczej		0.302**		
Individual contact Kontakty indywidualne		0.303**		
Group contact Kontakty grupowe		0.205**		
Mass contact Kontakty środowiskowe		0.296**		
Peer relationship Związek z partnerami		0.340**		
Attitude Postawa		0.045 NS		
Risk orientation Świadomość ryzyka		0.164*		
Aspiration Aspiracje		0.519**		
Potato problem awareness Świadomość problemów dotyczących produkcji ziemniaków		0.224**		

NS – not significant, *significant at 0.05 level of probability, **significant at 0.01 level of probability.
Source: own calculations from field data.
NS – nieistotne, *istotne na poziomie prawdopodobieństwa równym 0,05, **istotne na poziomie prawdopodobieństwa równym 0,01
Źródło: obliczenia własne na podstawie badań terenowych.

Out of 22 predicted variables, 16 namely education, training experience, crop production supervision, agricultural knowledge, potato production knowledge, innovativeness, annual income, cosmopoliteness, extension media contact, individual contact, group contact, mass contact, peer relationship, risk orientation, aspiration and potato problem awareness were positively correlated with the adoption of potato production technologies. Other 6 variables namely age, family size, family education, farm size, formal group affiliation and attitude had no significance.

CONTRIBUTION OF SELECTED PREDICT VARIABLES TO THE FARMERS' ADOPTION OF POTATO PRODUCTION TECHNOLOGIES

In order to find out the contribution of variability in predicting farmer's adoption of potato production technologies the problem of multi-co linearity, stepwise regression analysis was computed in the present study. According to Dropper and Smith [1981], the purpose of stepwise multiple regression analysis is to insert variables in turn until the regression equation is satisfactory. The objective of the regression model was to find out the contribution of the variables, which were significant only, apart from the problem of multi-co linearity on the adoption behaviour of the farmers. In order to find out the contribution of predict variables to farmers' adoption of potato technologies stepwise regression analysis was computed. Out of 22 variables, only 16 which had significant relationship with response variable based on the correlation results were selected for stepwise multiple regression analysis (Table 5).

Table 5. Summary of stepwise multiple regression analysis showing the contribution of all 22 independent variables to the adoption of potato production technologies
Tabela 5. Podsumowanie analizy wielokrotnej regresji krokowej ukazującej wpływ wszystkich 22 niezależnych zmiennych na zastosowanie technologii produkcji ziemniaków

Step No. Krok	Variables entered Poszczególne zmienne	R	R square R kwadrat	Adjusted R square Kwadrat R poprawiony	R square change Zmiana kwadratu R	Variance explained Objaśnienie wariancji
1	Innovativeness Innowacyjność	0.695	0.482	0.480	0.482	48.2
2	Potato production knowledge Wiedza z zakresu produkcji ziemniaków	0.761	0.579	0.575	0.097	09.7
3	Aspirations Aspiracje	0.776	0.603	0.598	0.024	02.4
4	Awareness Świadomość	0.791	0.626	0.619	0.023	02.3
5	Group contact Kontakty grupowe	0.796	0.634	0.626	0.009	0.9
6	Peer relationship Kontakty partnerskie	0.801	0.642	0.632	0.008	0.8
7	Attitude Motywacja	0.807	0.651	0.641	0.010	1.0
Total – Łącznie						65.30

Source: own calculations from field data.
Źródło: obliczenia własne na podstawie badań terenowych.

Data indicated that out of 22 variables, only 7 variables namely innovativeness, potato production knowledge, aspiration, potato problem awareness, group contact, peer relationship and attitude could finally enter the stepwise multiple regression equation.

These seven predict variables were important and combindly explained 65.30 percent of the total variation in predicting the farmers' adoption behaviour. But out of them, innovativeness singularly explained 48.2 percent of variation, because it played a most vital role in the whole process. Interest in any new innovation can make an individual aware to contact with all other relevant factors of influencing dissemination of new technology. Use of any new technology shows an individual as ready reference. As a whole, innovativeness leads other attribute of a farmer.

PATH ANALYSIS FOR MEASURING DIRECT AND INDIRECT EFFECT OF FARMERS' SELECTED CHARACTERISTICS TO THEIR ADOPTION OF POTATO PRODUCTION TECHNOLOGIES

According to Sasmal and Chakrabarty [1978], the technique of path co-efficient analysis involves a method of partitioning the total correlation between the response variable and the predict variables into direct effect of independent variables and it's indirect effects via third variable on response variable. Path co-efficient is simply a standardized partial regression co-efficient and as such measures the direct influence on one variable upon another and permits the separation of the correlation co-efficient into components of direct and indirect effects [Dewey and Lu 1959]. According to Li [1954], path co-efficient analysis is superior to multiple regression analysis, as it is free from effects of measuring unit, whatever be the actual units of measurement for the variables.

In the present study, correlation and stepwise multiple regression were conducted. It was not possible to find out the direct effects and indirect effects separately by the correlation test or stepwise multiple regression test. Path co-efficient analysis was applied in order to obtain clear understanding of the direct and indirect effects of selected seven independent variables namely Innovation, potato production knowledge, aspirations, potato problem awareness, group contact, peer relationship and attitude. These were entered into stepwise regression model of farmer's adoption of potato technologies. Path co-efficient shows the direct and indirect effects of selected seven predict variables with the farmers' adoption of modern potato production technologies (dependent variables) are presented in Table 6.

Analysis of data indicate that among the predicted variables, innovativeness had the highest positive direct effect (0.530) on the adoption of potato production technologies by the farmers, followed by aspiration, potato knowledge and peer relationship with a positive and substantial direct effect (0.244, 0.213 and 0.116) respectively. Potato problem awareness, group contact and attitude had negative direct effect on adoption. The variable group contact had the highest (0.306) total indirect effect and potato problem awareness had the lowest (0.69) indirect effects.

The innovativeness contributed 48.2 percent predicting the farmers' adoption of potato production technologies and had the highest positive direct effect (0.530). This was due to the fact that innovators are active information seekers about new ideas or technology. They have a high degree of media exposure and their intrapersonal network extend over wide area, reaching outside of their local system [Rogers 1995]. Potato production knowledge contributed 9.7 percent to the farmers' adoption of potato production technologies and had second highest indirect effect (296). The farmers were

Table 6. Path co-efficient showing the direct and indirect effects of selected predicted variables on the adoption of potato production technologies

Tabela 6. Współczynnik ścieżkowy obrazujący wpływ bezpośrednich i pośrednich zmiennych przewidywalnych na zastosowanie technologii produkcji ziemniaków

Predicted variable Zmienne przewidywalne	Direct and indirect effect of predicted variables Bezpośrednie i pośrednie zmienne przewidywalne							Indirect effect Wpływ po-średni	Direct effect Wpływ bezpo-średni
	innova-tiveness innowa-cyjność	potato production knowledge wiedza nt. produkcji ziemnia-ków	aspiration aspiracje	awareness świadomość	group contact kontakt grupowy	peer relation-ship relacje partnerskie	attitude motywacja		
Innovativeness Innowacyjność		0.06539	0.122	–0.00308	0.03737	0.03920	0.021094	0.165	0.530
Potato production knowledge Wiedza na temat produkcji ziem-niaków	0.16271		0.066856	0.052052	–0.016867	0.029696	0.00159	0.296	0.213
Aspiration Aspiracje	0.265	0.05836		–0.006314	–0.026361	0.014152	–0.029786	0.275	0.244
Awareness Świadomość	0.0106	–0.0712	0.01		0.003333	–0.006496	–0.0159	–0.069	–0.154
Group contact Kontakty grupowe	0.054528	0.029768	0.008624	–0.024442		–0.022896	0.17914	0.306	–0.101
Peer relationship Kontakty partner-skie	0.17914	0.054528	0.029768	0.008624	–0.024442		–0.022896	0.224	0.116
Attitude Motywacja	0.10547	–0.003195	0.068564	–0.0231	–0.021008	0.025056		0.151	–0.106

Source: own calculations from field data.
Źródło: obliczenia własne na podstawie badań terenowych.

supposed to get enough information in relation to potato which increased their knowledge level. It helps to adopt a new technology. The contribution of aspiration was 2.4 percent predicting the farmers' adoption of potato production technologies and had third position (0.275) for indirect effect. This was due to the fact that aspiration as a psychological factor of the farmers might play an mental an mental orientation related to adoption of potato production technologies. By nature, all people have particular mind sets. Strong will and aspiration will help farmers to accept and use new compatible technology. In this investigation it was disclosed that potato farmers were relaxed to incline their mental rigidity tending to accept the advantages of production technologies. It is one kind of extension contact which consists of many channels. It was assumed that the more contact of an individual, the more would be the influence of communication to him. Group contact, peer relationship and awareness contributed 0.9, 0.8 and 2.3 percent respectively. Peer relationship helps to an individual to receive professional information which can aspire a man to adopt new technology. It is assumed that the higher level of awareness about the subject may help farmers to cultivate the potato intensively. Attitude of potato growers contribut-

ed 1.0 percent to the adoption of potato production technologies with the direct and indirect effect negatively and positively. It may be inferred that other variable remaining constant, the attitude had substantial indirect effect.

CONCLUSION

From the preceding discussion, out of eleven production technologies for the adoption of potato fertilizer application method is more frequently adopted. It also appears that due to the fact that growers do not use recommended practices, adoption of potato production technologies by the growers in this study is not at satisfactory level. Stepwise multiple regression analysis depicted that seven variables contributed significantly to the adoption of potato production technologies and these are the key factors for adoption of potato production technologies. Path analysis indicated that those variables had both direct and indirect effects on the adoption. Hence the importance of these variables needs to be recognised and emphasis should be given. Thus it may be concluded that adoption variations in different technologies will not be improved unless effective steps are taken to increase farmers' exposure to get benefits of using such technologies as per recommendations. Therefore, attempt should be made by the competent authority to arrange motivational programme for increasing innovativeness, and knowledge in relation to potato production. An adult education and training programme may also help them to increase attitude and other variables.

REFERENCES

BBS. 2010. Yearbook of Agricultural Statistics of Bangladesh. Bangladesh Bureau of Statistics, Planning Division, Ministry of Planning, Government of the Peoples Republic of Bangladesh. Dhaka, Bangladesh.

BES. 2009. Bangladesh Economical Survey. Economical Advisory Section, Finance Division, Ministry of Finance, Government of the Peoples Republic of Bangladesh. June 2009.

Bhuiyan N.I., Parl D.N.R., Jabbar M.A., 2002. Feeding the extra million by 2025. Challenges for Rice Research and Extension in Bangladesh. A Keynote Paper Presented at National Workshop on Rice Research and Extension 2002. Bangladesh Rice Research Institute, Gazipur, Bangladesh 29-31 January, 2002.

DAE. 2010. A Plan Book of Upazilla-wise Crop Production in Rajshahi District (2009-2010). Department of Agricultural Extension, Office of the Deputy Director, Rajshahi. Bangladesh.

Dewey D.P., Lu K.H., 1959. A correlation of and path-coefficient analysis of components of crested wheat grass seed production. J. Agron. 51, 515-518.

Dropper N.K., Smith H., 1981. Applied regression analysis. Wiley, New York.

Farukh A.H.M., 2007. High Value Food Crop Production Technology Training Module. Dhaka: Project Director, Northwest Crop Diversification Project (NCDP), June 2007, pp.19-22.

Hasan M.M., 2003. Adoption of recommended potato cultivation practices by the farmers in some selected areas of Rajshahi District. M.Sc. Thesis. Department of Agricultural Extension Education. Bangladesh Agricultural University, Mymensingh, Bangladesh, 8-9.

Islam M.M., 1993. Adoption of improved practices in potato cultivation by the potato farmers of Sonatola Union under Bogra District. M.Sc. (Ag. Ext. Ed.) Thesis. Department of Agricultural Extension Education, Bangladesh Agricultural University, Mymensingh, Bangladesh, 65--66.

Li C.C., 1954. Population genetics. The University of Chicago Press, Chicago.
Muttaleb M.A., 1995. Farmers' preference matching and adoption of modern rice cultivation practices in Haor Area of Northeast Bangladesh. Ph.D. Thesis. Department of Agricultural Extension Education, Bangladesh Agricultural University, Mymensingh, Bangladesh, 208-212.
Netherlands Catalogue of Potato Varieties. 2013. Ed. M.R. Van-Diepan NIVAP, The Netherlands.
Rashid M.M., 1987. Potato production in Bangladesh. A Consultancy Report Prepared for FAO Regional Office for Asia and the Pacific, Bangkok, Thailand. Tuber Crops Research Center, Bangladesh Agricultural Research Institute, Joydevpur, Gazipur, Bangladesh.
Rogers F.M., 1995. Diffusion of innovations, 5th ed. The free press, New York.
Sasmal B.C., Chakrabarty K., 1978. Correlation and path co-efficient analysis of yield component in mesta (*Hibiscus Cannabinus* L.). Indian J. Heredity 10(2), 19-26.

WPŁYW RÓŻNYCH CZYNNIKÓW NA DOBÓR TECHNOLOGII PRODUKCJI ZIEMNIAKÓW W PÓŁNOCNO-ZACHODNIM BANGLADESZU

Streszczenie. Poniżej opisane badania zostały podjęte w celu oznaczenia czynników, które mają wpływ na wybór technologii produkcji ziemniaków. Wybory dokonane przez hodowców zostały zbadane za pomocą przetworzenia danych dotyczących punktowego oszacowania właściwego przygotowania ziemi, uprawy nowej odmiany, zastosowanej dawki nawozu, metody aplikacji nawozu, nawodnienia, środków ochrony roślin, jakości ziarna, technik zmienno-gatunkowych, daty sadzenia, wielkości nasion i odstępów między rzędami. Dane zebrano od 232 losowo wybranych rolników uprawiających ziemniaki. Zrobiono to przy pomocy ankiety przeprowadzonej ustnie w trzech powiatach dystryktu Rajshahi w Bangladeszu w okresie od lipca 2010 do lutego 2011 roku. Spośród 11 technik odnoszących się do uprawy ziemniaków, wskazania na nawadnianie jako najistotniejszą z nich znalazły się na 1. miejscu, podczas gdy odległości między rzędami na ostatnim. Większość plantatorów (46,55%) wykazała się średnim wskaźnikiem zastosowania technik, 29,74% znacznym oraz 23,71% niskim. Na podstawie współczynnika korelacji Pearsona stwierdzono, że spośród 22 zmiennych, 16 wykazało istotne pozytywne związki z zastosowanymi technikami produkcji ziemniaków. Wyniki przeprowadzonej krokowej analizy wielokrotnej regresji wykazały, że siedem zmiennych, tj.: innowacyjność, wiedza na temat produkcji ziemniaków, aspiracje, świadomość problemów występujących w trakcie produkcji, kontakty grupowe, partnerskie oraz postawa, przyczyniło się w znacznym stopniu do takiego wyniku. Łącznie zróżnicowanie osiągnęło 65,30% (całości zróżnicowania technologii). Analiza ścieżkowa wykazała, że te zmienne wpłynęły zarówno pośrednio, jak i bezpośrednio na przyjętą postawę. Hodowcy, którzy odznaczali się znaczną innowacyjnością, lepszą wiedzą tematyczną i wyższymi aspiracjami, częstszymi kontaktami z członkami zespołu, i z partnerami, oraz właściwymi postawami, łatwiej adaptowali techniki produkcji ziemniaków.

Słowa kluczowe: zastosowanie, techniki produkcji, ziemniaki, wpływ czynników

Zaakceptowano do druku – Accepted for print: 1.07.2014

Do cytowania – For citation: Uddin A.B.M.S., Rahman M.M., Alam M.B., Kamaly M.H.K., 2014. Factors contribution to the adoption of production technologies by potato growers in Northwest Bangladesh. J. Agribus. Rural Dev. 3(33), 283-297.