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## Usage Gaps in Components and Rates of Potato Technology Packages among Farmers in Welmera Woreda, Ethiopia

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### Abstract

*The paper intends to identify knowledge gaps in potato technology adoption among farm households in Welmera, Ethiopia. Within the woreda, four administrative kebeles were selected based on their potato production potential. From these kebeles, a total of 112 farm households were selected using simple random sampling method proportional to population size. The sampled households were interviewed by using structured interview schedule. Group discussions were undertaken with selected households, development agents and researchers to gather qualitative data. For data analysis, statistical tests like t-test, chi-square and one way ANOVA were used to test the variation of mean and association among the sampled households. About 79.5% of the households were male headed whereas the remaining 20.5% were female headed. ANOVA result indicated that there was significant variation in the adoption index score in sampled households. Non adopters, low adopter and high adopters account 46.4%, 27% and 27% of the selected households with the mean adoption index of 0.0000, 0.5233 and 0.74. Moreover, all recommended potato production packages were not implemented by all adopter farmers. Low adopters used seed rate, fertilizer rate, diffused light store and chemical application below the recommended packages. On the other hand, high adopters used seed rate and diffused light store below recommended quality and spacing and fertilizer application above recommended rate. The overall findings of the study underlined the high importance of institutional support in improving seed rate, diffused light store construction, spacing, fertilizer rate, and chemical application. Therefore, it is necessary to provide on farm extension training, strengthen cooperative societies, and improve market conditions to fill usage gap in adoption of improved potato production packages.*

**Key words:** Knowledge gaps, adoption, potato technology, recommendation

## 1. Introduction

Potato is among the major horticultural crops in general and root crops in particular that play a key role as a source of food and cash income for small-land holder producers. Ethiopia has many places where horticultural crops are produced in small scale and at commercial scales levels. Empirical evidence shows that the area under potato production in Ethiopia is about 73,095 hectares with an average national yield of 10 tons/ha for the main cropping season (CSA, 2007).

Because of that, Ethiopian Institute of Agricultural Research (EIAR) under its different research centers has been introducing different kinds of improved potato varieties. The released potato varieties, along with improved package of technologies, have been disseminated through MOA and its regional and grass root structure. For this reason most farmers in surrounding finfina oromiya special zone are able to produce potato tuber. However, some potato growing farmers do not apply all the recommended packages at the recommended rates. Identifying the usage gap on potato technology adoption is critical for professionals engaged in agricultural development, researchers, policy makers and institutions. This study aimed to usage Gaps in Components and Rates of Potato Technology Packages among Farmers in Welmera Woreda, Ethiopia. The study was conducted in Welmera woreda, one of the potato growing woredas of surrounding finfina Oromiya Special Zone.

## 2. Methodology

### 2.1 The study site

Welmera Woreda is one of the eight Woredas in Oromiya Special Zone, covering a total area of 755 Km<sup>2</sup>; 40 Km east of Addis Ababa and has 24 rural kebeles. According to 2007 Census data, the district had 83,784 a total population. The altitude of the district ranges between 2060-3380 meters above sea level. Temperature ranges from 0.1 up to 26.9 °C while the mean annual rainfall ranges from 1000 to 1100mm. The rainfall pattern is usually bimodal from January to June for *belge* and from June to October for

Meher time. Livestock's are used for meat and milk in addition to supporting crop production as draught power.

## 2.2 Sampling techniques

In this study, two types of sampling techniques were applied. These are purposive and simple random sampling techniques. The woreda and four administrative kebeles were selected purposively by reviewing secondary data about potato production experience and area coverage of the crop. After preparing up-to-date list of the sampling frame, households were selected based on probability proportional to size of total potato growing farmers in each Kebele. Following that 112 farmers were selected by using simple random sampling techniques.

## 2.3 Data type, source, data collection and analysis methods

Individual interview and four group discussions from each peasant association were conducted to gather qualitative and quantitative data. Relevant secondary data were collected from annual reports, journals, articles, chapters in books, and manuals. Descriptive statistics were applied for quantitative data type. In addition to that analytical techniques like t-tests, chi-square tests, and one way ANOVA were carried out.

Adoption Index (AI<sub>i</sub>) in this study indicates the extent of adoption of improved potato recommended packages. The farmers who meet the recommended rate in the packages were given 1 and 0 for those who did not. The formula was calculated as follows:

$$AI_i = \frac{LP_i + VA_i + SR_i + FR_i + CA_i + SP_i + SS_i + PM_i + WF_i + ST_i}{10} \times 100$$

Where;

- LP<sub>i</sub> Land preparation of *i* farmer
- VA<sub>i</sub> Varieties land used by *i*<sup>th</sup> farmer
- SR<sub>i</sub> Seed rate usage by *i*<sup>th</sup> farmer
- FR<sub>i</sub> Fertilizer rate usage by *i*<sup>th</sup> farmer
- CA<sub>i</sub> Chemical application by *i*<sup>th</sup> farmer
- SP<sub>i</sub> Spacing usage by *i*<sup>th</sup> farmer
- SS<sub>i</sub> Seed size usage by *i*<sup>th</sup> farmer
- PM<sub>i</sub> Planting method by *i*<sup>th</sup> farmer
- WF<sub>i</sub> Weeding / hoeing and hilling frequency applied by *i*<sup>th</sup> farmer
- ST<sub>i</sub> Seed storage method by *i*<sup>th</sup> farmer

This happened due to the fact that not all sampled households use the entire recommended potato package. On the basis of adoption index, respondent farmers were classified in to two categories, viz., low and high adopter.

### 3. Results and Discussion

#### 3.1 Extent of adoption of improved potato production package

In order to know the level of adoption of each respondent, the Adoption Index score was calculated. Before the calculation the technology packages were listed and weighted. Equal weights were given to all technology packages through discussion with woreda experts, development agents and researchers in the study area. The sampled households' adoption index scores were categorized into three adopter groups namely non-adopters, low adopters and high adopters. The actual adoption index score ranges from 0 to 1. Adoption index score of 0 point implies non-adoption of the overall improved potato production package. Statistical analysis of ANOVA indicated that there was significant variation ( $F= 50.796$ ,  $P=0.000$ ) based on the adoption index score among the three categories at 1% level of significance (Table 1).

**Table 1:** Distribution of respondents by adoption category of improved potato technologies

| Adoption Category | N   | percent | Adoption Index score | Mean   | SD      | F Value  | P Value |
|-------------------|-----|---------|----------------------|--------|---------|----------|---------|
| Non-adopters      | 52  | 46.4    | 0.00                 | 0.000  | 0.00000 |          |         |
| Low adopters      | 30  | 26.8    | 0.01-0.60            | 0.5233 | 0.09353 |          |         |
| High adopters     | 30  | 26.8    | 0.61-1               | 0.7467 | 0.05713 |          |         |
| Total             | 112 | 100     | 0.00-1               | 0.3482 | 0.32604 | 50.79*** | 0.000   |

Note: \*\*\* = significant at 1% level.

Source: Own survey data, 2011. \*\*\* = significant at 1% level.

As indicated in Table 1, non-adopters account for 46.4% with the mean adoption index of 0.0000. This indicated that non adopters were not practicing any of the recommended package and the technologies in the production year 2010. Next to non

adopters, low and high adopters constituted about 27% each. Low adopters have mean adoption index of 0.5233 while high adopters have mean adoption index 0.74.

### **Current Practices of Improved potato Production Package**

Farmers' current practice of technology components consists of varieties, seed rate, seed size, methods of planting, spacing, fertilizer rate, chemical spraying, weeding/hoeing and hilling frequency, number of seed in a hole, and seed storage type are discussed below.

#### **Improved potato varieties**

Gudane and Jalene improved potato varieties are widely grown in the study area. These varieties were released from Holetta research center located near by the study area and most farmers have been growing these varieties. The extent of varieties adoption was measured by the area covered by improved potato varieties by each farmer.

**Table 2:** Distribution of adopter households by the area coverage under improved potato Variety

| <b>Adoption category</b> | <b>N</b> | <b>Mean</b> | <b>SD</b> | <b>t</b> | <b>P value</b> |
|--------------------------|----------|-------------|-----------|----------|----------------|
| Low adopters             | 30       | 0.3047      | 0.24237   | 30.85*** | 0.0000         |
| High adopters            | 30       | 0.6858      | 0.41552   |          |                |
| Total                    | 60       | 0.4952      | 0.38817   |          |                |

Note: \*\*\* = the mean difference is significant at 1% level

Source: Own survey data, 2011

As shown in Table 2, the total household's average area coverage under improved potato varieties was 0.49 hectare. The minimum and maximum area covered by improved potato varieties were 0.13 and 1.50 hectare. The statistical analysis of t- test revealed the existence of significant difference between the two groups at 1% significant level (Table 2).

### Seed rate

Using disease free seed and appropriate seed rate are the most critical component of improved potato production. Using over and lower seed rate will cause excessive plant population or less plant population both leading to lower production. Research recommends a specified level of seed rate. However, depending on availability of quality seed and farmers' interest the recommended seed rate may or may not be applied as recommended. In the study area, farmers used a minimum of 12 quintal and a maximum of 28 quintal seed rate per hectare. Whereas the recommended seed rate for potato production is 20 quintals/hectare.

**Table 3: Average seeding rate applied by sample adopter households in quintal/ha**

| Adoption category | N  | Mean    | SD     | t value | P value |
|-------------------|----|---------|--------|---------|---------|
| Low adopters      | 30 | 18.2667 | 2.93   |         |         |
| High adopters     | 30 | 19.83   | 2.46   |         |         |
| Total             | 60 | 19.05   | 2.8008 | 2.575** | 0.029   |

Note: \*\* = the mean difference is significant at 95 % level.

Source: Own survey data, 2011;

According to the results indicated in Table 3, low and high adopters were using on average 18.29 and 19.86 qt /ha respectively. However, both categories have used the seed rate below the recommended rate, though the seed rate used by high adopter's category is close to the recommended rate. From group discussion, farmers explained that increasing the space between rows minimizes the quantity of the average seed rates. In 2010/2011 production year, potato growers' average seed cost incurred in one production season was 4560 birr. In the same year, the seed purchasing price ranged between 600 to 800 birr per quintal. Recently, most farmers became seed producers and hence are mostly using their own seed source. On the other hand, Holetta agricultural research center delivered good quality seed to scaling up the technologies.

**Table 4:** Distribution of sample households by sources of potato seed, 2010/2011 production year

| Source of seed      | Frequency | Percent |
|---------------------|-----------|---------|
| Local market        | 5         | 8.3     |
| Own /home           | 6         | 10.0    |
| MOA                 | 3         | 5.0     |
| Research center     | 30        | 50.0    |
| Cooperative         | 5         | 8.3     |
| NGO                 | 2         | 3.3     |
| Individual producer | 9         | 15.0    |
| Total               | 60        | 100     |

Source: own survey data, 2011.

As shown in Table 4, half of the adopters obtained seed from Holetta research center. From group discussion farmers said that Holetta research center gave them clean seed without cash and they will repay next year in kind (potato itself). Few numbers of sample households purchased improved seeds from cooperatives and local markets (Table 4).

#### **Fertilizer application**

In the study area, farmers have good knowledge on fertilizer application. However, some farmers did not apply the recommended fertilizer rate of 120kg (urea and DAP) per hectare. The maximum and minimum fertilizers applied by respondent farmers were 50 and 200 kg per hectare.

**Table 5:** Fertilizer rate applied by sample households in 2010/2011 production year

| Adoption category | N  | Mean     | SD       | T        | P value |
|-------------------|----|----------|----------|----------|---------|
| Low adopters      | 30 | 95.9333  | 37.74591 |          |         |
| High adopters     | 30 | 125.0667 | 37.75322 |          |         |
| Total             | 60 | 110.50   | 40.2077  | 2.328*** | 0.004   |

Note: \*\*\*the mean difference at 1% significant level

Source: Own survey, 2011.

According to the results indicated in Table 5, the average fertilizer rate applied by the respondent farmers was 110.50kg per hectare. This also revealed by statistical analysis of independent t-test ( $t=2.328$ ,  $P=0.004$ ), it shows that there is significant mean difference between the two groups. According to the information obtained during group discussion, farmers do not apply the recommended fertilizer rates since few years ago during when prices of fertilizers were very high.

#### Weeding/hoeing and hilling

The recommended number of weeding operations per cropping season is 2 times. The first weeding and hilling operation should be after 40 and 60 days of planting (HARC, 2005).

**Table 6:** Weeding frequency by sample households in 2010/2011 production year

| Adoption category | N  | Mean | SD    | T     | P value |
|-------------------|----|------|-------|-------|---------|
| Low adopters      | 30 | 2.20 | 0.407 |       |         |
| High adopters     | 30 | 2.33 | 0.479 |       |         |
| Total             | 60 | 2.27 | 0.446 | 1.161 | 0.250   |

Source: Own survey, 2011

The sampled respondent farmers practice weeding and hilling on average 2.27 times (Table 6). The independent t-test revealed that the difference in weeding and hilling practice is not statistically significant ( $t=1.161$ ,  $P=0.250$ ). Depending on the incidence of the weed and the amount of the rain, farmers decide on whether to increase frequency of weeding and hilling practice. Moreover, the area is highland and the farmers are enforced to hill the plant more than the recommended number of weeding and hilling frequency.

#### Number of seed in a hole

After the rows are prepared, farmers put the seed with an appropriate spacing. The recommended number of seed in each hole is one. The respondent farmers put on

average 1.10 seed in each hole. As shown in Table 7, the low adopters and high adopters were putting on average 1.17 and 1.03 seed in each hole, respectively. There are no statistically significant difference between the two groups ( $t=1.736$ ,  $P=0.880$ ).

**Table 7:** Number of seed put in a hole by sample households in 2010/2011 production year

| Adoption category | N  | Mean | SD    | t     | P value |
|-------------------|----|------|-------|-------|---------|
| Low adopters      | 30 | 1.17 | 0.379 |       |         |
| High adopters     | 30 | 1.03 | 0.183 |       |         |
| Total             | 60 | 1.10 | 0.303 | 1.736 | 0.880   |

Source: Own survey, 2011

#### Planting Method

Before planting, farmers prepare rows to prevent water logging and to manage the farm very easily. Majority of potato producer farmers use row planting method.

**Table 8:** Planting method by sample households in 2010/2011 production year

| Adopter Category | Planting method |     | Total | $\chi^2$ |
|------------------|-----------------|-----|-------|----------|
|                  | Broadcasting    | Row |       |          |
| Low adopters     | 2               | 28  | 30    |          |
| High adopters    | 0               | 30  | 30    |          |
| Total            | 2               | 58  | 60    | 2.069    |

Source: own survey, 2011

As shown in Table 8, all high adopters and all except 2 of the low adopters used row planting method. There is no statistically significant difference between the two groups on method of planting. In the study area, farmers have enough knowledge on row planting methods and almost all respondent farmers prefer row planting method rather than broadcasting method.

### Chemical application

"Late blight" and "Bacteria wilt" are the common diseases that occurred during production period. Both affect the quantity and quality of the product. To prevent the Late Blight disease, two times spray of redomile chemical at after 50 and 70 days of planting is recommended. The incidence of the disease is common in all farmers farm. So, farmers are compelled to spray the chemical before the incidence of potato blight goes worse. All high adopters and 19 low adopters have used radomile chemical to prevent "Late blight" disease (Table 9). Chi-square test was the existence of strong correlation between the two groups ( $\chi^2=13.469$ ,  $P=0.000$ ) at 1% significant level. Farmers indicated that radomile chemical is expensive.

Table 9: Chemical user by sample households in 2010/2011 production year

| Adoption category | Used chemicals/Radomile |      | Total | $\chi^2$ |
|-------------------|-------------------------|------|-------|----------|
|                   | "yes"                   | "No" |       |          |
| Low adopters      | 19                      | 11   | 30    | 13.5***  |
| High adopters     | 30                      | 0    | 30    |          |
| Total             |                         | 11   | 60    |          |

Source: own survey, 2011, \*\*\* ( $\chi^2=13.469$ ,  $p=0.000$ ) significant 1% level

### Seed Storage

Few years ago, most farmers in the study area were using holes to reserve potato seeds. At present time most potato producer farmers use diffused light store (DLS) for seed reservation. It helps the seed tuber to have enough sun light, ventilated and to mak management easy.

**Table 10:** Number of DLS constructed by sample households in 2010/2011 production year

|                         |               |  | Storage type |     | Total | $\chi^2$ |
|-------------------------|---------------|--|--------------|-----|-------|----------|
| Category                |               |  | Floor        | DLS |       |          |
| Adopter and non-adopter | Low adopters  |  | 12           | 18  | 30    |          |
|                         | High adopters |  | 5            | 25  | 30    |          |
| Total                   |               |  | 17           | 43  | 60    | 9.17***  |

Source: own survey, 2011, ( $\chi^2=9.170$ ,  $p=0.010$ )=significant at 1% significant level

Farmers who used DLS for seed reservation can have disease free and good quality seeds for the next season. Twenty five and 18 high and low adopters were using DLS for seed reservation (Table 10). The statistical analysis of chi-square also shows positive correlation between the two groups ( $\chi^2=9.170$ ,  $p=0.010$ ) at 1% significant level.

#### Seed size

The major seed tuber selection criteria employed by farmers were healthiness and size of tuber (Gebermedihn, 2005). Medium sized tubers are recommended for seed purpose. Before the product is supplied to market, farmers commonly sort the potato tubers into three different sizes. They use most of the time small sized tuber for home consumption whereas medium and big sized tubers for seed and marketing purpose. Almost all respondents were medium sized potato tubers for seed purpose. As shown in Table 11, there is no statistically significant difference between the two groups in terms of the sizes of seeds used ( $\chi^2=3.018$ ,  $p=0.221$ ).

#### Spacing

Spacing is one of the management practices which determine the level of mineral competition. The recommended spacing for potato production is 30cm between plant and 75cm between rows. From sampled households, high adopters used over the recommended spacing (30x80) than low adopters. As shown in Table 12, a total of 13 and 19 low adopters and high adopters used spacing beyond the recommended practices (30x80).

**Table 11:** Seed size selection by sample households in 2010/2011 production year

| Category      | Seed size |        | Total | $\chi^2$ |
|---------------|-----------|--------|-------|----------|
|               | Large     | medium |       |          |
| Low adopters  | 1         | 29     | 30    | 3.018    |
| High adopters | 0         | 30     | 30    |          |
| Total         | 1         | 59     | 60    |          |

Source: own survey, 2011

However, there was no significant difference between the two groups ( $\chi^2=4.519$ ,  $P=0.477$ ).

**Table 12:** Spacing by sample households in 2010/2011 production year

| Adoption category | Spacing |       | Total | $\chi^2$ |
|-------------------|---------|-------|-------|----------|
|                   | 30x75   | 30x80 |       |          |
| Low adopters      | 17      | 13    | 30    | 4.519    |
| High adopters     | 11      | 19    | 30    |          |
| Total             | 28      | 32    | 60    |          |

Source: own survey, 2011

Farmers also indicated that increasing the space between rows would ease management like hoeing and hilling, chemical spraying. Beyond that the tuber grows bigger in size, and is highly preferred for market.

#### 4. Conclusion and recommendation

Non adopters, low adopter and high adopters account for 46.4%, 27% and 27% of the respondents with the mean adoption index of 0.0000, 0.5233 and 0.74. Moreover, all recommended potato production packages were not implemented by all adopter farmers. Low adopters used seed rate, fertilizer rate, diffused light store and chemical application below the recommended packages. On the other hand, high adopters used seed rate and diffused light store below recommended quality and spacing and fertilizer application above recommended rate. The overall finding of the study underlined the high importance of institutional support in improving seed rate, diffused light store construction, spacing fertilizer rate and chemical application.

Therefore research centers, development agents and other stakeholders need to provide on farm extension training to fill knowledge gaps in adoption of improved potato production packages.

From the study, half of the adopters obtained potato seeds from Holetta research center. Few sample households purchased improved seeds from cooperatives and local markets. So, the woreda administrative and related offices should increase number of cooperatives and improve the services provided by the existing cooperatives.

It is reported that potato seed quality has gradually decreased in terms of yield performance and resistance to diseases. To keep the seed quality to the regained standard, there should be monitoring mechanisms and training facilities to seed producers. So, the woreda agricultural office and Holetta Research Center should strengthen the training and seed monitoring system. Producers and extension agents need adequate skills in production management practices starting from seed selection to post harvest technology suitable at their level. Marketing principles, bargaining skills, business planning, quality management and post harvest handling of horticultural products are some of the interventions needed in the study area. Thus, the woreda agricultural office and Holetta agricultural research center should take the responsibilities to meet the above requirements.

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