ANALYSIS OF THE VIABILITY OF USING HYDROPONICS IN GROWTH OF BARLEY AS A FODDER CROP AMONG RURAL SMALL-SCALE FARMERS IN KIAMBU COUNTY

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A RESEARCH PROPOSAL SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT OF BACHELOR IN SCIENCE OF AGRIBUSINESS MANAGEMENT DEPARTMENT OF AGRICULTURAL ECONOMICS UNIVERSITY OF NAIROBI

Submitted to:
MR. KENNEDY PAMBO
I take this chance to first and foremost thank the Almighty God, without whose grace this work would have been impossible.

My sincere gratitude goes to my supervisor Mr. Kennedy Pambo who through his unrelenting support and guidance I have been able to write this proposal. May the Almighty God bless you abundantly.

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1.0 INTRODUCTION
1.1 Background information

Barley (Hordeum vulgare) is a common crop for both animal and human diets. It is one of the most popular cereals. It is one of the oldest crops to be domesticated by man. It has been cultivated for over 8000 years (Zohary and Hopf, 2000). However, the crop was only introduced in Kenya during the colonial regime as a fodder crop. The commercialization began in 1929 when it started being used for beer making. It is adaptable to most parts of the world from arctic to the tropics. Among the major barley growers and exporters include European union, Australia, and Canada while the largest importers are Saudi Arabia (mainly as livestock feed), Japan (for food and malt production), and China (Taylor et al., 2005).

In Kenya the crop does well in medium to high attitudes with good rainfall or else substitution with irrigation. Annual rainfall should be about 635mm. The country has a growing area for barley of about 85000 hectares of which only 20000 hectares is being utilized. This clearly shows the country has not utilized its full potential on this crop. The nutritional contents of barley include; high protein and energy contents, high fibre content, high in vitamin A, E and K. (Agriculture information Centre, 2002).

Barley as a livestock feed was primarily used as a source of protein and energy in beef cattle diet. When the crop is properly processed, mixed, and fed it is an excellent feed. The processing of barley needs a lot of care in order to maximize digestion efficiency and maintain stable rumen functions mostly among the ruminants (Jason, 2012). Barley is also grown for production of malt which is a main component of the alcoholic drinks. Malt production is done by steeping barley in the water until it starts to germinate thereafter it is roasted and crushed in a mill. It is then used in distilling and brewing and also in making malted milk drinks (Kelly, 1997).

The benefits of barley to this country have majorly been observed in the beer industry. However the contribution of the crop to livestock production as a feed cannot be ignored despite being less utilized. Kenya has a flourishing beer industry with high quality beer. Among the factors that have contributed to this fact is: Good climate for agricultural production, the availability of barley especially from large-scale farming, easily affordable labor, availability of local market. Kenya is also centrally located with access to regional markets such as EAC and COMESA. The industry has also contributed immensely in providing employment to many Kenyans both
directly and indirectly. It is also a major revenue generator for the country from the taxes the government collects, (Declan et al., 2005).

The major challenges facing the barley production in Kenya is the fact that most Kenyans have not yet embraced the growth of the crop mainly on the crop as a livestock feed. To most livestock farmers there is not enough sensitization on the importance of the crop as a livestock feed. This can be majorly attributed to lack of enough extensional officers who are responsible for disseminating the information to farmers.

Among the possible solution to the problem of fodder in this area include use of fodder trees, fodder cereals such as maize, oat, rye, finger millet; perennial legumes such alfalfa, lucerne and desmodium; and maize and grass silage. However most of the above fodder crops require a significant amount of land space.

Hydroponics is a system of agriculture whereby plants are grown without the use of soil as a media. There are two chief merits of the soil-less cultivation of plants. First, hydroponics may potentially produce much higher crop yields. Also, hydroponics can be used in places where in-ground agriculture or gardening is not possible.

This system has several advantages: The system is cost effective and contains all the nutrients the animal requires. Barley provides about 25% proteins, minimal labor needed. Barley has a lot of sugar hence provide a lot of energy. It uses 80% less water than growing fodder in the soil. It is possible to control the nutrition levels in their entirety thus, lower nutrition requirements. No nutrition pollution is released into the environment because of the controlled system. Pests and diseases are easier to get rid of than in soil.

1.2 The problem statement

By growing barley using hydroponics, it is advantageous and more applicable in small-scale farming. There are problems of enough land and the alternative cost of feed is quite high, (Sneath and McItoosh, 2003). It is also worth noting that there is a significant reduction in dry matter as the barley sprout grows as compared to the barley seeds, (Sneath and McItoosh, 2003). The digestibility of barley as a fodder increases as the sprouting time increases, (Peer and Leeson, 1985). Hydroponics can be used to deal with the issue of food insecurity, in Ecuador the method
was applied using simple hydroponic system materials that were cost effective to farmers, (Caldeyn and Cajamara, 2003). Research has clearly shown that the young and rapidly growing barley sprouts contain very high levels of enzymes. These enzymes are normally inactive when the barley seeds are dry due to presence of inhibitors, (Chavan and Kadam, 1989). The technology has been used for many years in the Australia and the United States of America. Latin America is slowly adopting the technology.

In general, there is a lot of literature that is available on the various aspects of hydroponics, that is, nutritional, costs and acceptability by farmers (Dung et al., 2010; Hinton 2007; Tudor et al., 2003). These studies however are mainly based on large-scale farmers and little on the urban and peri-urban farming. There is little literature addressing the application, acceptability and impact of hydroponics fodder to small-scale farmers especially in the rural areas. Of the few small-scale farmers who have adopted the farming method, they have reported positive results and are encouraging other farmers to adopt it. The proposed study seeks to add on to the available literature, detailing for the first time the importance of embracing hydroponics barley as an alternative source of fodder to the small-scale farmers in the rural areas. Having adequate knowledge on the small-scale farmers’ level of use of the technology for farming will go a long way in addressing the problem of fodder for livestock in the populated areas.

1.3 Purpose/objective of the study

a) To assess small-scale farmers knowledge on use of hydroponics to grow fodder.

b) To identify the factors affecting adoption of hydroponic technology.

1.4 Hypothesis

Social-Economic factors don’t affect hydroponic technology.

1.5 Justification of the study

In this study, important information concerning the importance of hydroponic fodder to small-scale farmers and the acceptability of the method in the rural areas especially in Kiambu County will be addressed. This is a county which despite being highly productive is densely populated and is among the most populated counties in Kenya. The agricultural land has been highly taken up by homesteads at the expense of agricultural productivity. Lately Kiambu has become a hub
for real estate constructions; this can be attributed to the nearness of the county to the capital city of Kenya, Nairobi. This study seeks to help small-scale farmers who can take advantage of the agricultural friendly environment in the county and also use the small land they have to achieve productivity of their livestock and improve their economic levels.

This will have a great impact on the decisions that the various stakeholders will take. The government of Kenya will need this information in order to put in place measures that will enhance adoption of this technology. This may require adequate training of extensional officers and equipping them with the necessary equipment that will help them reach out to many small-scale farmers in the rural areas.

To the dairy industry this information will be very useful in that increased fodder means increased milk production especially from the cattle. The concerned stakeholders in this industry will have to make decisions on whether to or not to increase their capacity in milk processing, storage and value addition. This will enhance the productivity and income for the small-scale farmers.

This fodder is very effective when fed on pigs and poultry. This means that the meat industry will experience increased production and supply of meat. This call for decisions to be made that will enhance handling of the increased supply. Decisions on the number of abattoirs to construct and storage facility will be very crucial.

To the suppliers of all the materials that make a hydroponic system especially those involved in making of nutrients that are needed in making the hydroponic nutrients this information is very useful. They will have to make decisions that will cater for the increased demand for the nutrients to the farmers.

1.6 Study Area

Kiambu County is located in Central Kenya. It covers an area of 2543 sq. km with an average temp of 18.7 degrees celsius and 989 mm of rainfall per annum. With rich highland soils coupled with very favorable climatic conditions, agriculture plays a very important role in the county’s economy. However due its proximity to Nairobi and limited land resources, the service sector is slowly replacing agriculture as a major economic activity. The county is undergoing rapid
urbanization as a result. The major urban centers are Thika, Ruiru, Gatundu, Limuru, Kabete, Githunguri, Kiambaa, Kikuyu, Kiambu, Lari and Karuri. The main economic activity in the county is agriculture – tea, coffee, dairy farming, poultry and horticulture. With the high population the county has, it is a good source of labour for industrial production and agricultural value addition or the service sector. The county also has good tourists’ attractions and forest resources conducive for eco-tourism, camping and expeditions sites.

1.7 Organization of the study

This proposal is organized as follows; chapter 1 introduction; it details, background information, problem statement, objectives of the study, hypothesis to be tested, justification of the study and study area; chapter 2 literature review; chapter 3 Methodology; chapter 4 results and discussion; chapter 5 timeframe finally; chapter 5 conclusion; and finally a list of references.
2.0 Literature review

Sneath and Mcltosh (2003) analyzed the economics of producing barley sprouts for commercial cattle production through hydroponic system feed under Australian conditions. They used informal interviews (phone calls, face to face interviews), literature review and analysis of gathered information in order to identify opportunities and issues that would require further research. They found out that barley sprouts are highly nutritious, expensive to establish, results into reduction of the dry matter as compared to the barley grains and increased crude protein. However the study majorly focused on use of high technology hydroponics therefore negating the cost-effectiveness of using locally available materials.

Martin Caldeyro-Stajano (2003) observed that among other factors that make hydroponic technology not to be spread included, limited information dissemination on the benefits of the technology; challenges of obtaining expertise who are trained and have knowledge of hydroponics; few producers of nutrient solutions who will avail them at a low cost; and the fact that the society is still conservative as majority still believe that fertilizers and other nutrients that are needed in the hydroponics are toxic. Martin (2003) also found out that simple hydroponics which is obtained at a lower cost goes a long way in enhancing food security.

Joseph Mooney (2002) observed that growing of plants especially barley in soil-less culture which is nutrients rich has been proved to be both financially and environmentally friendly. He concluded that the technology is a great asset for highly populated regions where growing space is a problem and where agriculture is difficult. The technology also allows farmers to have 100% control of the fodder production throughout the year; this avoids effects of the weather such as hails or shine that could destroy the fodder. They are able to get both quantity and quality in the fodder which in turn will translate to good productivity of livestock.
3.0 METHODOLOGY

3.1 Data collection procedure

Primary data was collected through the use of semi-structured questionnaires. This was backed by face to face discussion, face to face ensured all questions were answered and clarification given to the respondents when needed. The study targeted farmers and random sampling technique was used. Sample size was identified on the basis of central limit theorem whereby a sample of thirty or more respondents would have a normal distribution regardless of the population, as the number of occurrences increases, the expected results moves closer to the actual results. In CLT any sample size greater than 30 can be used to infer population characteristics from the selected sample.

30 respondents were selected and interviewed on viability of hydroponics technology and the factors that are likely to affect the adoption of the technology. Data analysis was done using Statistical Package for Social Sciences (SPSS) v.16.

3.2 Model used

Ordinary least square (OLS) regression model was used in the study to analyze the relationship between the viability of the hydroponics technology to the rural small-scale farmers and the socio-economic variables. The model is normally used to show a linear relationship between the dependent variable and the independent variable and it stated as follows:

\[ Y = \alpha_i + \beta X_i + u_i \]

Where:

- \( Y \) = Viability of Hydroponics technology to rural small-scale farmers (dependent variable).
- \( \alpha_i \) = Constant (other factors which were not include in the model but affect the dependent variable)
- \( \beta \) = Co-efficient (to be determined by the variable)
- \( X_i \) = Variable (independent variable)
- \( u_i \) = Error term.
### 3.3 Variables included in the model

Table 1: Variables used in the model

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description of the Variable</th>
<th>Expected sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Age of the farmer (years)</td>
<td>-</td>
</tr>
<tr>
<td>Hydroknow</td>
<td>Level of knowledge on hydroponics (1=Good, 0=poor)</td>
<td>+</td>
</tr>
<tr>
<td>Occupation</td>
<td>Occupation of the respondent (1=farmer, 0=other employment)</td>
<td>+</td>
</tr>
<tr>
<td>Familiarity</td>
<td>Familiarity to hydroponic technology (1=yes, 0=no)</td>
<td>+</td>
</tr>
<tr>
<td>Education</td>
<td>Education levels (1=higher education, 0=secondary and below)</td>
<td>+</td>
</tr>
<tr>
<td>Gender</td>
<td>Gender of the respondent (1=male, 0=female)</td>
<td>±</td>
</tr>
<tr>
<td>Income</td>
<td>Income levels (1=above 30000, 0=below 30000)</td>
<td>+</td>
</tr>
</tbody>
</table>

Age as a variable: The young people are more likely to adapt to new farming technology as compared to the older generations who tend to be more conservative and thus unwilling to try new farming techniques.

Educational level: It is expected that farmers and individuals with higher educational levels will be highly likely to embrace the hydroponic technology as compared to those with less education (mostly below secondary education).

Gender: Female are more likely to adapt new technology of farming as they are the ones more often involved in farming activities, however their decision will be highly influenced/affected by the male who are often then the household heads and make major decisions in their households.

Familiarity: Those are familiar with the technology either by seeing it being practiced or have sufficient knowledge are more likely to respond positively.
Occupation: Those who practice farming as a sole source of livelihood are likely to adopt the technology, however those who don’t depend entirely on farming are likely to be reluctant in adopting the technology.

Income levels: People with higher level of incomes will be able to afford the cost of inputs and materials for setting up the structure.
4.0 RESULTS AND DISCUSSION

4.1 Small-scale farmers’ knowledge of hydroponics technology.

Table 2: Descriptive statistics for frequencies and continuous variables.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Descriptive statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level of knowledge on hydroponics (% good)</td>
<td>60</td>
</tr>
<tr>
<td>Familiarity to hydroponics technology (% Yes)</td>
<td>76</td>
</tr>
<tr>
<td>Medium where the technology was being practiced (% Farm)</td>
<td>23.3</td>
</tr>
<tr>
<td>Seen barley being grown as a fodder crop (% Yes)</td>
<td>56.7</td>
</tr>
<tr>
<td>Medium used to grow barley fodder (% hydroponics)</td>
<td>60</td>
</tr>
</tbody>
</table>

Majority of the interviewees had quite a good knowledge on the various aspects of the technology. They had knowledge on the various crops that can be grown under this system, the types of materials required to setup structures that the system will be housed and some of the nutrients needed to grow the crops. A great number of the farmers have come across hydroponics system in use. However most of those who said they are familiar with the technology, they have seen it through the social media from various agricultural programs aired on local television stations and on the internet. Very few of them had visited or come across farms where the technology is being practiced. A relatively good percentage had seen barley being grown as a fodder crop and majority of whom had witnessed this through hydroponics system as opposed to the soil-medium. However this doesn’t mean that barley is widely grown using hydroponics because as earlier noted, the majority of the interviewees had only seen the technology being practiced in the social-media and not in the farm scenario. From the above results, it is clear that there is little or no input by the agricultural extension services on the awareness of this technology.

Comment [K P4]: STOP JOKING! Show the full descriptive results and share with me your data plus analysis.

Comment [K P5]: You are not serious!
4.2 Factors affecting hydroponics technology adoption

Relationship between viability of hydroponics technology to rural small-scale farmers and the factors affecting the adoptability of the technology.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Standard error</th>
<th>Significance (P-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>1.390</td>
<td>0.386</td>
<td>0.002</td>
</tr>
<tr>
<td>Age of farmer</td>
<td>-0.026</td>
<td>0.007</td>
<td>0.001</td>
</tr>
<tr>
<td>Hydroknow</td>
<td>0.3910.157</td>
<td>0.021</td>
<td></td>
</tr>
<tr>
<td>Occupation</td>
<td>0.1450.117</td>
<td>0.228</td>
<td></td>
</tr>
<tr>
<td>Familiarity</td>
<td>-0.266</td>
<td>0.191</td>
<td>0.177</td>
</tr>
<tr>
<td>Gender</td>
<td>0.0820.106</td>
<td>0.446</td>
<td></td>
</tr>
<tr>
<td>Education levels</td>
<td>0.2180.119</td>
<td>0.081</td>
<td></td>
</tr>
<tr>
<td>Income levels</td>
<td>-0.003</td>
<td>0.116</td>
<td>0.981</td>
</tr>
</tbody>
</table>

Regression results from the above table indicates; three variables are significant, i.e. age of the farmer, knowledge of hydroponics, and education levels. However occupation, familiarity, gender and income levels were significant. The constant represent other factors that were not included in the model and which directly affect the dependent variable, its coefficient is identical to the predicted value of the dependent variable for those cases whose independent variable is 0. For every increase in one year(age of the farmer), it reduces the acceptability of the hydroponics technology by 2.6 percent. This inverse relationship is in consistent with the predictions made earlier. Older people tend to be inflexible and prefer to retain old farming practices rather than new farming technology, on the contrary young people readily accept new technology. There is a direct relationship between the knowledge on hydroponics that a farmer has and their ability to adopt the hydroponics technology i.e. for every unit of increased knowledge on hydroponics, there is 39.1% increase in level of acceptability of the technology. This can be explained by the fact that as one gets more and more knowledge on this technology, they are able to understand its advantage and disadvantages. It is also easier to engage in farming practices that you have some prior information rather than an entirely new idea. This variable is also consistent with the predicted results about the impact of hydroponics knowledge to the acceptability of the technology. Increased education levels have a positive influence on the level of hydroponics
technology acceptability. For every increase in a unit of education level, there is an increase in 21.8% level of acceptability. The more people are educated and exposed, the higher their rate of flexibility to new technologies. Education influences household ability to process information and cause farmers to have better understanding and interpretation of information. The result is in consistent with the predicted results.

5.0 CONCLUSION

The aim of this study was to assess small-scale farmers’ knowledge on use of hydroponics to grow fodder and to determine the factors affecting adoption/ acceptability of hydroponics technology. From the results obtained, age of the farmer, knowledge on hydroponics technology and the education levels of the farmers were significant factors that will heavily contribute to the acceptability of the technology. The technology has not been well embraced this is evidenced by the fact that most of the interviewees had only seen the technology on social media mainly television programs. There is need for increased extension services that will disseminate the knowledge on hydroponics technology and help bridge the gap between those with high level of knowledge and those with little or no knowledge on the same subject. Availability of the materials needed to setup the system should be made available mainly by the government through the ministry of Agriculture.
6.0 References


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