

**ECONOMIC EVALUATION OF HERBICIDES USED FOR WEED CONTROL IN GROUNDNUT FARMING IN SIKHAR BLOCK OF MIRZAPUR DISTRICT IN INDIA**

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***Abstract***

Weeds from a large portion of crops are not being removed due to the shortage of labour and increasing wage rate that has been the cause of highest crops lost in India. Countries across the world have solved this problem during the period of the scarcity of labour and higher weeding cost by adopting the chemical method of weed control. Therefore, a field survey was conducted during Kharif Season, November 2017 in Sikhar block of Mirzapur District in Uttar Pradesh. The Major objective of the study was to evaluate the effect of weed control methods on its cost, growth yield and economic return in two varieties of groundnut. Partial budgeting and Likert scale have been used to analyze the major problem and economic constraint of farmers. This partial budgeting analysis commonly is used in estimating the profitability of relatively minor change in an existing system. More specifically, it evaluated the relative economic importance of the difference between chemical and manual methods of weed control. Majority of groundnut farmers were reported that the herbicides can be used for weed control and now without herbicides it is difficult since there is shortage of labour and increasing wage rate. In economic analysis, we found that in case of two times manual method of weed control at 25+50 days after sown (DAS) the maximum cost was Rs.8402.58 per acre while the maximum cost in the case of two times chemical method of weed control at around 25+50 days after sown (DAS) was only Rs.1504.36 per acre. Total output recorded from manual weeding groundnut was 28798.46 kg/acre followed by 29015.19 kg/acre from chemical weeding. Shathi variety (s2) of groundnut found to be more productive as compared to Koushal variety (s1).

**Key words:** Days after Sown (DAS), Groundnut, Herbicides, Labour scarcity, Partial budgeting.

**JEL Classification:** Q-10, Q-16, J-43

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## Introduction

Groundnut or peanut is known as the king of oilseed. In India it is also known as poor men's cashew nut. Groundnut originated in South America and was introduced in India around half of the sixteenth century (Talwar,2004). Groundnut is the sixth most important oilseed crop in the world. It contains 48-50% of oil and 26-28% of protein and is a rich source of dietary fiber, minerals, and vitamins. The world wide groundnut is grown in 25.32 million hectares with a total production of 42.77 million metric tones and an average productivity of 1.69 metric t/ha. Groundnut is grown in more than 100 countries. Developing countries constitute 97% of the global area and 94% of the global production of this crop. The production of groundnut is concentrated in Asia and Africa with 56% and 40% of the global area and 68% and 25% of the global production, respectively (Foreign Agriculture Service/USDA, January, 2018).

**Table.1**

### Food value of groundnut:

Content	Percentage
Protein	25.20
Oil	48.20
Starch	11.50
Soluble sugar	4.50
Crude Fiber	2.10
Moisture	6.00

**Source:** Peanut in Local and Global food Systems Series Report No.5, Dept. of Anthropology, University of Georgia, 2007.

The food value of groundnut is presented in table-1. The most common ways of using groundnut are in form of oil and roasted snack. They also called as peanut and known as 'Mungfali' in Hindi, 'Pallelu' in Telugu, 'Kadalai' in Tamil, 'Nilakkadala' in Malayalam, 'Kadale kaayi' in Kannada, 'Singdana' in Gujarati and 'Shengdaane' in Marathi. It is easily available around the year and almost everywhere in India and around the world.

The productivity of groundnut in India is comparatively low, because of many problems, beset in its cultivation. Weed control is one of the serious problems. It not only reduces yield, but also

interfere in pegging, pod development and harvesting of the crop. India ranks among top three producers of groundnut in the World and stood 2nd in the world groundnut production scenario with an annual groundnut seed production of 6.7 million metric tons and covers maximum area of the world with 5 million hectares while China's rank is first by producing 17 million metric tons out of 42.77 million metric tons of total world production and covers 4.85 million hectares while the world wide groundnut is grown in 25.32 million hectare. (Foreign Agricultural Service/USDA January, 2018, Office of Global Analysis)

All India production of Kharif groundnut is estimated at 7077397 million tones with an average yield of 1,704 kg/ha. The five states covered by survey collectively contributed 83.7 percent of the National production. Gujarat Recorded for 43.2 percent of the national production followed by Rajasthan (19.9%), Andhra Pradesh (11.8%), Karnataka (4.7%) and Maharashtra (4.2%). The highest state average yield of 2,380 kg/ha is estimated for Rajasthan followed by 1,879 kg/ha and 1,272 kg/ha for Gujarat and Andhra Pradesh respectively.(Directorate of Oilseeds Development, Hyderabad, 2017)

The groundnut production in India was 7180.5 thousand tones in 2015-16. It decreased by -221.2 thousand tones as compared to the groundnut production of 7401.7 thousand tones in the year 2014-15. There were 9 States having groundnut production of more than 100 thousand tones viz. Gujarat, Rajasthan, Tamil Nadu, Andhra Pradesh, Karnataka, Madhya Pradesh, Maharashtra, West Bengal and Telangana in 2015-16 (Ministry of Agriculture and Farmers Welfare, 2017).

A recent study suggested that around one-third of oilseeds, half of the food grain and an equal amount of pulses product were lost due to poor weed control (Jay G. Varshney and M.B.B. Prasad Babu, 2008,pp.2). Annual Report of AICRP on Weed Control (2011-12) says that weeds and other pests are the causes of crop loss in India. Weeds were estimated the first major cause by contributing 33 percent followed by 26 percent due to insect, 21 percent due to other reason and 20 percent due to disease. Indian farmers use 63 percent of the total chemical to solve the problem related to insect while only 26 percent of the crop is lost due to the insect. Just opposite 18 percent of pesticides are used to solve the problem of weed, while 33 percent of crops lost due to weed.

In India still majority of farmers are using manual methods of weed control but now scarcity of labour and increasing wage rate became a big constraint in this process. Many studies and reports state that the labour market of rural area is in the process of change. Labours are moving from agriculture to non-agriculture sector and new generation youth are not interested to work in agriculture sector. (NSSO Employment and Unemployment Surveys: 38th Round (1983), 50th Round (1993-94), 61st Round (2004-05) and 66th Round (2009-10), FICCI report on Labour in Indian Agriculture: A Growing Challenge, 2014), (FICCI, 2015, Ashok Gulati, Surbhi Jain & Nidhi Satija, 2013)

### **Statement of the problem:**

Conventional methods of weed control, like hand weeding and inter-culture operations remain the most widely used methods in India and other Asian countries to control the weeds in Groundnut fields. These methods have been found effective in groundnut but are tedious, time consuming and expensive. The frequent rains and high humidity are the hurdles in manual or mechanical operations. Nevertheless, mechanical operation is only possible when weeds have attained certain size but till that the crops already become damaged. Due to the scarcity of labour and higher wage rate, it has been difficult to control weeds with old techniques, therefore a large proportion of crops are being lost every year due to weed in India. Infestation by wide spectrum of weed flora including grass, sedges and broad leaved is one of the major causes of low yield in groundnut in India. Since manual weeding was cumbersome and time consuming, chemical control found to be preferably the alternative solution. It is also more efficient and economic. Therefore, there is need to examine the implementation of this chemical for weeds control, evaluate its economic cost and farmers experience about using this chemical at ground level. So that it could be recommended at the national level to solve the problems of weed control and loss of groundnut crops.

Weeds are more detrimental to crop yields than either diseases or pests and it is necessary to control so that the crop plants achieve their full production potential. Costly input such as seeds and fertilizers used under dry land conditions become uneconomic to weed control. Therefore weed control is the single most important factor for higher crop production dry land and normal agriculture.

The application of post-emergence herbicides in groundnut during kharif season 2015 resulted in lowest weed density, highest weed control efficiency and lowest cost. (SatyaKumari Sharma, B.K. Sagarka, J.A. Chudasama, H.M. Bhuvra and N.B. Sagarka, 2014; Directorate of Groundnut Research, Annual Report 2015-16). Intelligent use of herbicide has led to crop management that is more efficient, sustainable, and productive. With effective policies, proper regulation, and safety training, use of pesticide will continue to play an important role in food production. Along with better pest management, pesticides have led to the development of improved agronomic practices like no till, conservation tillage, higher plant densities, increased yields, and the efficient use of water and nutrients. Pesticides lead to more sustainable agriculture when it is applied in safe and smart ways (Stephen C. Weller, Albert K. Culbreath, Leonard Gianessi, Larry D. Godfrey 2014). Herbicide is the most successful weed control technology ever developed, it is cost effective, fairly easy to apply, have persistence that can be managed, and offer flexibility in application time. They are eco-friendly if applied at proper dose, method and time, besides being quite safer in comparison to other pesticides like insecticides, P.K. Singh (DWR, 2013), R.K. Singh (IAS, BHU, 2014).

### **Critical Period of Weed Control:**

The critical period of weed control is said to be the period of time in which weed control is necessary to avoid significant yield loss (Nazarko et al., 2005). The best time to control weeds and the length of the critical period depend on a number of variables including weed emergence timing, weed densities, the competitive ability of weeds compared to crops, and environmental factors. The critical period of groundnut is 30 to 60 days. This period is crucial for controlling weeds effectively and preventing excessive interference with the crop. Different crops are susceptible to interference from weeds at different times. “The average yield loss was about 30 per cent whereas, under poor management conditions, yield loss by weeds upto 60 per cent had been reported (Daya et al., 1987). Kalaiselvan et al. (1991) stated that weed free condition from 15 to 40 days after sowing was essential for getting maximum yield. Varaprasad and Shanti (1993) and Murthy et al. (1994) reported that yield losses to the tune of 35 to 80 per cent due to weeds competition in groundnut” (R. SathyaPriya, C. Chinnusamy, P. Manickasundaram & C. Babu, 2016). The competition ability of weeds is more harmful and serious when the crop is

young. Weed should be removed from crops before critical period. Actually, critical period is the stage after which weed growth does not affect crop yields.

**Table.2:**

**Critical period of Weed control days after sowing (DAS)**

Crops	Critical Period (Days)
Direct seeded Rice, Maize, Sorghum, Sunflower, Sesame and Rapeseed-mustard	15-45
Transplanted Rice, Pearl millet, Wheat, Peas, jute, Cauliflower, Cabbage and tomato	30-45
Green gram, black gram, cowpea and okra	15-30
Soybean and potato	20-45
Casto, lentil, Chickpea, French bean and Groundnut	30-60
Pigeon pea	15-60
Onion	30-75
Sugarcane	30-120

Directorate of Weed Research-ICAR, 2012-13, India

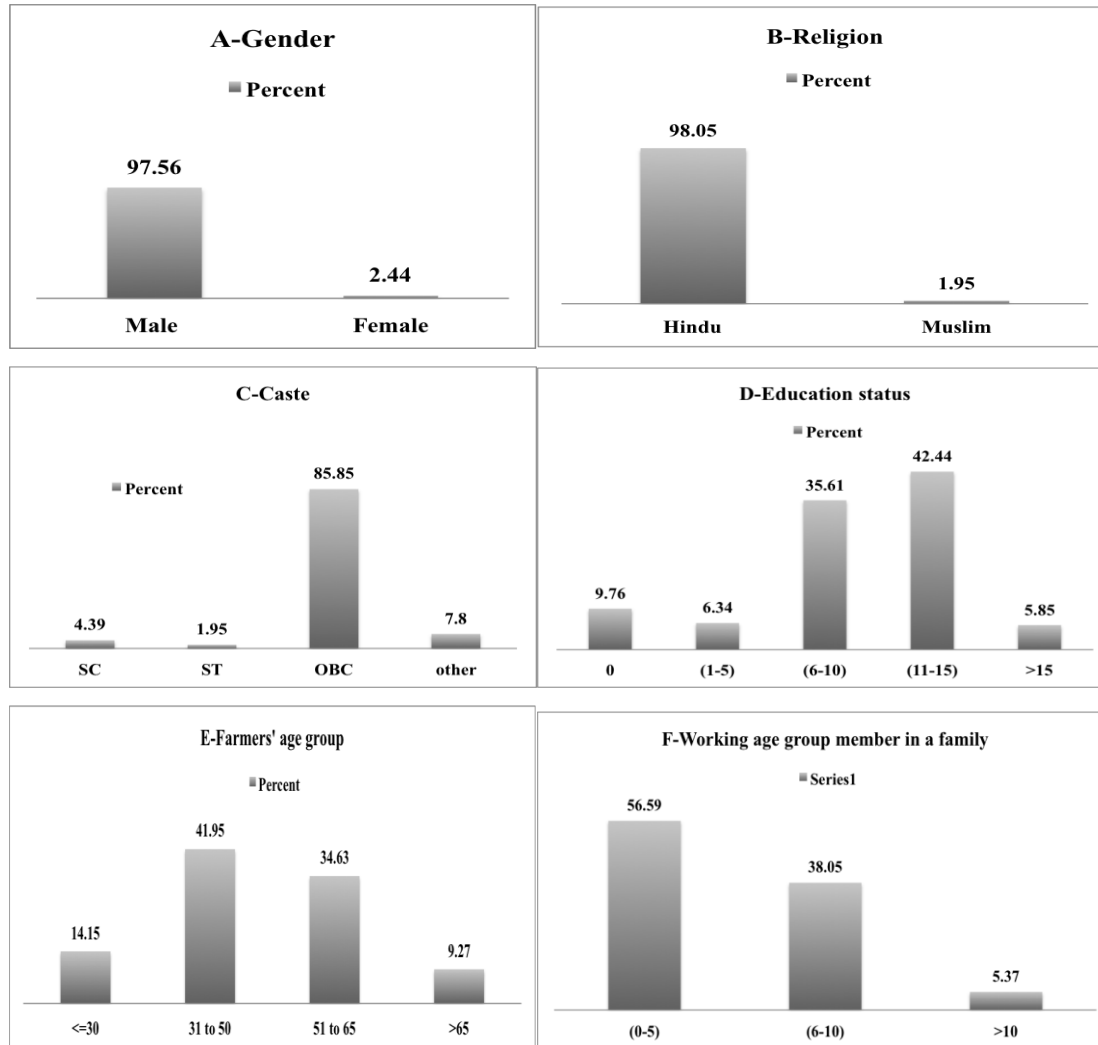
**Methods and technique:**

A field survey was conducted during *kharif* season, November, 2017 in Sikhar block of Mirzapur District in Uttar Pradesh. This survey was done through personal interview with the help of pretest-structured schedule. First week of July to last week of October is recorded for the farming period of groundnut in this district. Mirzapur is located at 25.15°N - 82.58°E. Groundnut is essentially a tropical plant so the best condition for groundnut cropping is the availability of proper sun light and sandy loam soil with a pH of 5.9–7. It requires a long and warm growing season. The most favorable climatic conditions for groundnuts are a well-distributed rainfall of at least 50 centimeters during the growing season, abundance of sunlight and relatively warm temperature. It seems that plant will grow best when the mean temperature is 21°C to 26.5°C. Lower temperatures are not suitable for its proper development. During the ripening period, it requires about a month of warm, dry weather. The target of this survey was to get information

about the groundnut farming of Sikhar block. Generally two types of groundnut were recorded, *Koushal and Shathi*. The population of this survey was groundnut farmer of this block. The population of this survey was only groundnut farmers of this block. 11 villages randomly were selected for primary survey out of 57 villages, because nature of sown area of this block is remaining unchanged. 205 farmers of these selected villages have been interviewed by randomly sampling methods. The selected villages and number of farmers from each village (in bracket) are Sikhar (57), Bagaha (34), Ramgarh (31), Magaraha (18), Katherwa (14), Gorauya (14), Hansipur (10), Lalpur (09), Khanpur (07), Premapur (06) and Pachraon (05). Farmers who have different size of groundnut field were interviewed and the various weed control treatments were examined to compare the economic advantages of herbicides. For this, we took costs of different inputs, herbicide and labour. Mostly groundnut farming of this area is dependent on weather and farmers do not use irrigation in groundnut crops

### **Partial Budgeting:**

A budget is simply a plan to coordinate the inflow and outflow of resources to achieve a given set of objectives. Farm budgeting is concerned with organizing resources on a farm to maximize profits. This study is concerned mostly with the calculation of the economic rate of return. This partial budget is a simplest form of budgetary analysis, commonly is used in estimating the profitability of relatively minor change in an existing system. It is a form of marginal analysis, designed to show the net increase or decrease in net farm income resulting from proposed changes. Therefore, this work has adopted partial budgeting analysis to compare of groundnut weeds control cost through various treatments and its impact on groundnut production. Various treatments of weeds control cost have been considered as a variable cost. Opportunity cost of family labour is also considered to calculate its cost. This cost is defined as the value of any resource in its best alternative use. This budgeting approach is called partial because it does not include all production cost, but only those, which change or vary between the farmer's current production practices.

**Figure-1****Status of Groundnut Farmers (Graphs:A,B,C,D,E and F)**

Out of 205 groundnut farmers, 97.56% were recorded as male and almost all respondents belong to Hindu religion. Among various caste, 85.85% farmers belong to OBC followed by 7.8 % of others, 4.39% SC and only one groundnut farmer was recorded from ST caste. 42.44% groundnut farmers were intermediate and graduates followed by 35.61% educated with the level of class 6 to 10, that is good for adopting innovative methods of weed control.

**Results:**

With quantitative data, this survey has also estimated all images in the form of qualitative data. The survey asked about farmers' opinion on different aspects of weed control in



groundnut. In the focused groups, around 95 percent of respondents were agreed about herbicides could be used in crops to remove unwanted weeds and they agreed that now a day farming is difficult without herbicides. Majority of respondents (56.14%) reported that chemical method of weed control is more productive as compared to manual weeding (table-3).

**Table-3****Farmers' opinion on some relevant issues related to weed control through herbicides**

	<b>Strongly agree</b>	<b>not agree</b>	<b>Can't say</b>	<b>Agree</b>	<b>Strongly agree</b>
<b>Do you think, herbicides can be used to remove weed?</b>					
Frequency	2	4	6	121	72
Percent	0.98	1.95	2.93	59.02	35.12
<b>Do you think, now doing farming is difficult without herbicides?</b>					
Frequency	9	6	5	88	97
Percent	4.39	2.93	2.44	42.93	47.32
<b>Do you feel, somewhere weed control with herbicides is more productive?</b>					
Frequency	23	46	16	65	44
Percent	11.86	23.71	8.25	33.51	22.68
<b>Do you use non-selective herbicides to avoid much tillage?</b>					
Frequency	18	34	5	91	51
Percent	9.05	17.09	2.51	45.73	25.63
<b>Do feel, less water is required in crops with herbicides?</b>					
Frequency	60	70	18	28	21
Percent	30.46	35.53	9.14	14.21	10.66
<b>Have ever your crops been influenced by pest and insect due to a high density of weeds?</b>					
Frequency	9	19	3	97	68
Percent	4.59	9.69	1.53	49.49	34.69
<b>Do you feel, more fertilizer and pesticides are required those are influenced by a high density of weed?</b>					
Frequency	10	22	1	89	72
Percent	5.15	11.34	0.52	45.88	37.11

Based on Researcher's own survey data 2017

A study (Gianessi & Sujata Sankula, 2003) state that the increasing use of herbicides for weed control play a significant role in the reduction of soil erosion and herbicides replace tillage for

weed control that reduces the use of water. In fact, heremany respondents (24.87%) agreed thatthe herbicides reduce the use of water by saving moisture and reducing tillage in crops.

**Table-4**

**Weed density and Treatments Details**

Treatments	Seed types	N	1 <sup>st</sup> chemical weeding	2 <sup>nd</sup> Chemical weeding	1 <sup>st</sup> manual weeding	2 <sup>nd</sup> manual weeding	Weed density
t1	S1	18	0.00	0.00	30.61	0.00	1.94
t1	S2	8	0.00	0.00	30.50	0.00	2.38
t2	S1	8	0.00	0.00	25.25	49.50	2.25
t2	S2	11	0.00	0.00	26.55	50.55	2.55
t3	S1	14	27.14	0.00	0.00	0.00	2.00
t3	S2	6	28.00	0.00	0.00	0.00	2.00
t4	S1	8	25.625	50.375	0.00	0.00	1.875
t4	S2	6	25.83	49.50	0.00	0.00	1.67
t5	S1	60	27.10	0.00	44.07	0.00	2.18
t5	S2	36	24.67	0.00	46.50	0.00	2.11

Based onResearcher's own survey data 2017

Five types of weed control treatments have been examined on the basis of three weeds density (Low, Normal and High) in two varieties of groundnut seeds. These treatments have been categorized on the basis of following methods: One time manual weeding (t1) at around 30 days after shown(DAS),two times manual weeding (t2) at around 26+50DAS, one time chemical weeding (t3) at around 27 DAS, two times chemical weeding (t4) at around 26+51 DAS and one time chemical along with one time manual weeding (t5) at around 27+44 days after shown. It was recorded that on an average first time weed control treatment was conducted either through chemical or manual at 24-27 DAS followed by second times at around 45-50 DAS and these are closely similar to scientific recommended period of weed control in groundnut (Directorate of Weed Research). Farmers' opinion on weeding timing and seed sown timing were also recorded for every treatment on the basis of given 1 (low),2 (semi) and 3(high) ranks. Mostly weed density was estimated more than 2, which is showing high density of weed. Majority of weeds

had emerged by 25 days of crop growth at Sikhar block of Mirzapur district. Different weed control treatments affected the density of total weeds significantly.

**Table-5**

Treatments	Seeds	Wage	No. Labour	Chemical Quantity in gram	Chemical cost	Chemical cost with Spray cost	Output in Kg	Gross Return	Total weed management Cost	Net Return	Benefit cost ratio BCR
t1	S1	3081.99	34.70	0	0.00	0.00	437.59	19472.67	3081.99	16390.68	6.31
t1	S2	4625.60	48.28	0	0.00	0.00	604.99	26921.91	4625.60	22296.31	5.82
t2	S1	7218.40	71.51	0	0.00	0.00	589.68	26240.76	7218.40	19022.36	3.63
t2	S2	8402.58	81.06	0	0.00	0.00	647.16	28798.46	8402.58	20395.88	3.42
t3	S1	0.00	0.00	34.633	625.83	855.83	432.31	19237.60	855.83	18381.77	22.47
t3	S2	0.00	0.00	42.767	798.93	992.27	740.36	32946.09	992.27	31953.82	33.20
t4	S1	0.00	0.00	71.82	1256.36	1451.36	510.16	22702.12	1451.36	21250.76	15.64
t4	S2	0.00	0.00	73.696	1311.02	1504.36	652.03	29015.19	1504.36	27510.83	19.28
t5	S1	3133.89	33.42	35.177	661.46	851.46	406.75	18100.39	3985.35	14115.04	4.54
t5	S2	3477.65	33.34	33.408	586.43	790.87	656.21	29201.42	4268.52	24932.90	6.84

Source: Per acre results were calculated, based on Researcher's own survey data 2017

### Economic analysis:

In modern agriculture, feasibility of adoption of an agro-technique can be judged on the basis of additional return due to it over the established one. The economics of various treatments was worked out on the basis of average yield obtained (Table-5). Result of the present investigation indicated that there is appreciable variation in net return because of various weed control treatments.

By economic analysis, it is observed that the maximum weeding cost involved in case of two times manual weeding (t2) Rs.8402.58 per acre. The lowest cost of production is involved in t3 for one-time weed control by the post-emergence application of herbicides.

The averaged data over the year indicated that the highest out-put (740.36kg/acre) was due to treatment (t3) in second variety of groundnut crop (s2), it was also estimated for highest net return (Rs.31953.82/acre) with 33.20 benefit cost ratio over the year while Rs.22296.31 net

return was estimated from treatment (t1) in second variety of crop (s2) with 5.82 benefit cost ratio. Post-emergence application of herbicides of imezathaiper followed by one hand weeding (t5) at 46.50 days stage provided second highest out-put in second variety of groundnut crop and it was much effective as compared to t2 and t4 in similar variety of groundnut.

Per acre requirement of labor was recorded around 33- 48 for one-time manual and 70-80 for two times manual weeding followed by around Rs.3000-Rs.4600 for one-time manual weeding and Rs.7200-Rs.8400 for two times manual weeding. In the case of chemical weed control treatment, it was recorded 0.346-0.427 kg/per acre for one time and 0.718-0.736 kg/per acre for two times followed by around Rs.855 to Rs.952 for one time chemical weeding and Rs.1451-Rs.1504 for two times chemical weeding, it is important to note here that the spray cost in the case of chemical weeding was already included in it.

Overall results show that the chemical weeding cost is much cheaper as compared to manual weeding even it did not make any negative change in output. It is also important to note that second variety of groundnut (s2) was found to be more productive as compared to seed s1. Numbers of workers required for manual weeding is much higher which shows it will take much time to implement for weed control and it will also damage the crop. According to Directorate of Weed Research, groundnut crop should be weed free in 30-60 days after sowing.

### **Discussion:**

Majority of weeds had emerged by 25<sup>th</sup> day of crop growth at Sikhar block. This indicates that competition between crop and weeds was maximum during the first 25 days of crop growth while groundnut crop needs a weed free condition for first 30 to 60 days and after that there is no additional advantage in keeping groundnut crop weed free. Weed control in groundnut crops production is difficult due to scarce of labour and high wage rate. In this situation, herbicides could be an option to solve this problem. This study is showing that post-emergence application of herbicides is found to be cost-effective as compared to manual method of weed control. Due to scarce of workers, manual method of weed control takes much time while groundnut crop should be weed free within critical period of weed control. One time chemical weeding cost is around ¼ of manual weeding cost.

According to some estimates, by the year 2020, nearly 50% of the population would be living in urban areas, creating an unprecedented shortage of labour force in agriculture. Therefore, in future, management of weeds through improved technologies involving herbicides and improved weeding tools will attain more significance, the result of which would be labour saving, better and timely weed control and ultimately increase in food production. The data pertaining to economics of various weed control treatments are presented in table-5. The highest cost of weed control treatment was recorded where hand weeding was performed twice while twice post-emergence application of herbicides was found  $\frac{1}{4}$  of this cost.

### **Conclusion**

Post-emergence application of herbicide has found to be cost-effective as compared to manual methods of weed control. The present study shows that the herbicides may be used for best alternative of manual method of weed control. It reduces water requirement by making long time moisture in the soil and reduces the use of fertilizer and chemicals. Post-emergence application of 300-350g/ha herbicides in high density weed at 24-27 and 40 -50 DAS remove weeds from groundnut crops. Use of herbicides does not influence adversely the parameter of groundnut production. *Shathi* (s2) variety of groundnut found to be more productive as compared to *Koushal* variety of groundnut (s1).

### **Reference:**

Abhay Kumar, R. (2016). *Annual Report 2015-16*. Directorate of Groundnut Research, Gujarat: ICAR. Directorate of Groundnut Research. Gujarat: ICAR.

Gianessi, L. a. (2012, January). *The Importance of Herbicides for Natural Resource Conservation on the U.S.* Crop Life Foundation Washington.

*Groundnut Production of Various States in 2015-16*. (2017, June 15). (Rajya Sabha) Retrieved from Groundnut Production of Various States in 2015-16 | Open Government Data Platform India Blog: <https://community.data.gov.in/groundnut-production-of-various-states-in-2015-16>.

Horton. "Partial Budget Analysis for On-Farm Potato Research." *Technical Information Bulletin* (International, Potato Center (CIP)), June 1982.

Ranganatha. (2011). *Vision 2030*. Indian Council Of Agriculture Science, Directorate of Weed Research. Gujrat: Directorate of Weed Research.

Sharma, S. B. (2015). Impact of new herbicides on growth, development and yield analysis of groundnut. (R. i. Sciences, Ed.) *Research in Environment and Life Sciences*, 8 (1), 109-112.

Singh, P. (2013). Introduction to Weed Science and Challenges. CAFT on Agro-ecological Approaches towards Sustainable Agriculture Production.

Singh, R. K. (2014). Short Communication Weed Management in Groundnut with Imazethapyr + Surfactant. *Indian Journal of Weed Science*, 46 (3), 302-304.

Singh, S. P. (2004). *Some Success Stories in Classical Biological Control of Agricultural Pests in India*. Asia-Pacific Association of Agricultural Research Institutions. Bangkok: FAO-RAP, Maliwan Mansion.

Sodhia, S. (2014). Herbicides residues in soil, water, plants and non-targeted organisms and human health implications: an Indian perspective. *Indian Journal of Weed Science*, 46, 66-85.

SS Rana, MC Rana. "Principles and Practices of Weed Management." Department of Agronomy, Forages, and Grassland Management College of Agriculture, CSK Himachal Pradesh KrishiVishvavidyalaya, Palampur, 2016.

Varshney, J. G. (2008). Future Scenario of Weed Management in India. *Indian Journal of Weed Science*, 40 (40(1&2)), 1-9.