Polythene Mulch Technology in Groundnut

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1. Introduction

India has the largest number of commercial varieties catering to the requirements of different eco-regions. It is bestowed with diverse agro-climatic conditions, which provide unique opportunity to grow wide range of oilseed crops. Groundnut is the premier among all oilseeds crops in India; it covers 35 per cent of total oilseed cover in India (7.07 million ha) and contributes 40 percent of total production (7.3 million tonnes). The productivity level has increased from 722 kg/ha during (1950-55) to around 1036 kg/ha in recent years. The productivity level of groundnut is low as compared to other countries and fluctuate widely (500-1500 kg/ha) depending upon growing condition.

Productivity Enhancement-a Need

The present per capita vegetable oil consumption in India is 12.00 kg, whereas the per capita consumption of developed countries is 51.20 kg in USA, 45.60 kg in Canada, 49.40 kg in EU etc, indicating a wide gap in consumption levels between developed and developing countries. Besides this gap, the growth of population also exerts pressure on demand level for vegetable oils especially in a country like India. For bridging the domestic demand and supply gap of edible oils the government resorted to heavy imports. This led to depletion of precious foreign exchange exorbitantly and thereby heavy burden on the exchequer. The import shoots up manifold from **84 thousand tones** in 1970-71 to around **4196 thousand tones** in 1999-00. Besides the above said reasons, the goal to achieve self-reliant India and also to eliminate **"dependency syndrome"** on other countries, productivity increase in oilseeds is vital.

Although India has about 20% of world area in oilseeds, its contribution is less than 10% of world production. The major increase in oilseeds production can be achieved in India through the horizontal expansion and also through vertical increase in groundnut crop. The horizontal expansion in the densely populated country like India is limited and only option available is to increase through vertical increase (productivity increase) to meet the growing needs.

Productivity Enhancement-Ways

It is imperative that with the growing population as well as increase in per capita incomes and thereby the standard of living, the demand for vegetable oils and fats is increasing day by day. To meet this demand the different options available to increase production are:

1. technological innovation and effective implementation.
2. increase in use of resources like land, labour, etc
3. capital accumulation in agriculture.

Among these options the developing country like India can easily exploit the first option **"technological innovation and effective implementation"** in which positive sum game (output) is greater than negative sum game (inputs).

Sustainable Groundnut Production Technology

It is well known fact that adoption of HYV technology since the mid sixties has resulted in enhanced productivity levels in India. This productivity enhancement was mainly in cereal crops like paddy and wheat. But in oilseeds the upswing in yield levels was achieved after the introduction of Technology Mission On Oilseeds (TMO) during 1986. Researches undertaken by several institutes over the years had culminated in the development of location and situation specific agro-production and protection technologies.

The identification of location specific, synergistic and compatible technologies also helped to enhance groundnut production in India. Since groundnut growing area is maximum under rainfed condition (kharif), several technologies were developed to cater the needs of dry land groundnut growing farmers. However, the average productivity during Kharif and Rabi/summer season hovers around 1000kg/ha and 1500kg/ha, which are much lower than the potential. Although scope for increasing **kharif groundnut** productivity is limited, the scope is enormous for Rabi/Summer groundnut by appropriate production technology like Polythene Mulch.

A Contemporary Success story in China

The Exemplary achievement in Polythene Mulch Groundnut (PMG) technology along with improved package of production helped China to uplift the national average yield of groundnut from 1.14 tones/ha in early 1960's to 2.19 tones/ha in mid 1990's a record increase of 92.11%. In the last 35 years, China attained an exponential production growth rate of 5.7%; Consequently, China with an area of 3.8 million hectares under groundnut produces 10.3 million tones of nuts in shell, which is 37% of the total world groundnut production. This phenomenal achievement in Chinese groundnut productivity has been attributed to the two major developments :

- Large-scale introduction of medium-bold seeded varieties of medium duration having better genetic plasticity, withdrawing small-seeded short-duration as well as long duration varieties from the production system.

- Introduction of polythene film mulch and extension of improved cultural practices.

Indian Initiatives

In India, use of polythene mulch film, for achieving high groundnut yields was in a conceptual stage till late 80's. The first experiment conducted simultaneously with transparent and black polythene sheet (50 micron minimum thickness available) on winter groundnut sown at NRCG, Junagadh and PAU, Ludhiana during early 90's. The results showed there was an increase in soil temperature above the normal levels by 6-7 °C. Consequently 70% germination within two weeks of planting was obtained as against 22% in control. However, there was very little impact of early germination on yield as the sheets were removed after the emergence within 3 weeks and subsequently exposing the seedling under the prevailing low temperature.

However, following Dr.M.S.Basu's visit to China (1995) and taking a clue from the use of ultra-thin (5-6 micron) polythene film mulch, which revolutionized groundnut yield in China, NRCG under the leadership of Dr.Basu approached IPCL, Baroda to introduce such film in India. The IPCL could produce mulch film of 7-8 micron and that was tested in medium black-cotton soils of Maharashtra involving Shri.Gunde an innovative groundnut farmer. Subsequently with the supply of one tonne film by IPCL free of cost large-scale field trials with polythene mulch were conducted for 2 consecutive years during summer season following Broad Bed-and-Furrow (BBF) method of planting which resulted in 5.0-7.0 tonnes dry pod yield/ha as against 2.6 tonnes in control (non-mulched). The varieties used were TG 26, ICGS 11 and TAG 24. The net monetary return on a rupee spent was Rs. 2.26 within a span of 4 months-seed to seed. The reasons for such a steady increase in yields have been attributed to:

- Better retention of soil moisture
- Initial increase of soil temperature
- Increased efficiency of soil micro-organisms
- Improved crop canopy micro-climate
- Reduced crop weed competition
- Reduced incidence of sucking pests in the initial stages of crop growth due to glittering effect of the film
- Cuts-down the water requirement of irrigated summer groundnut by about 40%
- Increased seed oil and ratio of oleic/linoleic acid
- The crop maturity hastened by about 7-10 days
- Slowed down the process of salinity build-up in root zone by arresting soil evaporation in saline coastal areas

With this exciting initial achievement, large-scale trials on Polythene Mulch Groundnut (PMG) were conducted at different locations and different crop-growing situations in India.

Experimental Sites

Situation	Location
Rabi/Summer, Rice fallow/ Residual moisture	Bhubaneswar (Orissa), Mohanpur (West Bengal), Jorhat (Assam), Panjim (Goa) and Manipur
Summer Irrigated	Vriddhachalam (Tamil Nadu), Kolhapur (Maharashtra), Junagadh (Gujarat), Dharwad (Karnataka) and Agra (UP).
Spring Irrigated	Ludhiana (Punjab)

Technical programme of PMG Trials

The trials were conducted at strategic locations under different situations by adopting

1. Broad-bed furrow (BBF) without polythene mulch
2. Broad-bed Furrow (BBF) with polythene mulch
3. Flat-bed (FB) without polythene mulch, and
4. Flat-bed (FB) with polythene mulch.

The Recommended / popular variety of the zone / region was used to test yield and other parameters.

Situation I: Rabi/Summer, Rice fallow/Residual moisture/ minimal irrigation

Extensive trials were conducted at different locations in Orissa, Assam, Manipur and Goa under this situation consecutively for three years from 1997-2000. The results revealed that pod yield was 70 percent more under BBF with polythene mulch than the BBF without mulch across these locations. Similarly Flat Bed (FB) with polythene mulch yielded 70-75 percent higher than FB without polythene mulch, indicating the beneficial effects of PMG technology under Rabi/Summer, rice fallow/residual moisture. The results of the trials are presented in Table 1.0

Table 1.0 Results of PMG trials under Rabi/summer rice fallow residual moisture/minimal irrigation (1997-00)

Sr. No.	Method of Planting	Yield kg/ha					Mean Yield kg/ha	% Increase in yield
		Orissa	Manipur	Assam	Goa	W. Bengal		
1.	BBF without Polythene mulch	2526	270	1536	2461	1515	1475	69.7
2.	BBF with Polythene mulch	4167	1590	1574	4366	1971	2504	
3.	Flat Bed without Polythene mulch	2272	170	1391	2842	1504	1476	72.5
4.	Flat Bed with Polythene mulch	3542	2210	1473	4872	1773	2547	

BBF : Broad Bed and Furrow

Situation II: Summer irrigated

The experiments were conducted for two years (1998 & 1999) under summer irrigated conditions across four states, namely Tamil Nadu, Maharastra, Gujarat and Uttar Pradesh. It was found that that BBF with polythene mulch technology generated higher pod yields of 18-25 percent compared to BBF without polythene mulch (Table 2.0).

Table 2.0 Results of PMG trials under summer irrigated condition

Sr. No.	Method of Planting	Yield kg/ha				Mean Yield kg/ha	% Increase in yield
		TN	MH	UP	GUJ		
1.	BBF without Polythene mulch	1662	3692	2580	1892	2456	23.2
2.	BBF with Polythene mulch	2560	4271	2980	2300	3028	
3.	Flat Bed without Polythene mulch	1760	3627	2930	1897	2553	18.8
4.	Flat Bed with Polythene mulch	2393	4165	3383	2202	3036	

BBF : Broad Bed and Furrow

Situation III: Spring irrigated

Extensive experiments under spring irrigated conditions were conducted in different locations of Punjab during the year 1999.The results revealed that on an average 40 percent yield increase was resulted under spring irrigated conditions using PMG technology (Table 3.0).

Table 3.0 PMG trials under Spring irrigated condition

Sr. No.	Method of Planting	Punjab kg/ha Loc1	Loc2	Loc3	Loc4	Loc5	Loc6	Loc7	Mean	% Increase in yield
1.	BBF without Polythene mulch	1920	1690	1870	2010	1730	2080	1890	1884	39.8
2.	BBF with Polythene mulch	2640	2275	2600	2830	2530	2920	2640	2633	

BBF : Broad Bed and Furrow
LOC : Location

The highly **encouraging results** obtained from different situations strategic locations paved way to conduct **On-Farm PMG Demonstrations** in target areas viz Rabi/Summer, rice fallow/residual moisture minimal irrigation, summer irrigated and spring irrigated with special funding of the NOVOD Board.

2. Pooled Results of Demonstrations Under Different Situations

Rabi/Summer, rice fallow/residual moisture/ minimal irrigation

The demonstrations conducted in different locations during 1997-98 yielded similar results like the trials in previous years. The yield obtained through PMG was 40 percent higher when compared to demonstrations without polythene mulch. These demonstrations were conducted at the targeted locations of Goa and West Bengal. During the year 1998-99 the demonstrations were further extended to different locations of West Bengal and Orissa. The yield obtained through PMG technology was higher to an extent of 45 per cent compared to without polythene mulch.

Summer Irrigated

The PMG demonstrations conducted under this situation in the states of Rajasthan, Gujarat, Maharashtra during the years 1998 and 1999 gave 20 percent and 45 percent higher yield respectively compared to Non-PMG technology. Similar results were obtained from the demonstration conducted by the zonal coordination unit (zone v), Hyderabad.

The FLD results corroborate the results obtained through the trials under similar situations. In view of this spectacular yield increase due to PMG the following **recommendations** were made for promotion of this technology by the All India Kharif Groundnut Workshop held at Dharwad-2002.

The house recommended the Polythene Mulch Groundnut Technology (PMG) for its adoption in the situations / areas / states of:

a. **Rice fallow residual moisture situation in Orissa, Tamilnadu, Assam, West Bengal.**
b. **Summer irrigated situations of Gujarat, Maharashtra and Karnataka.**
c. **Low temperature areas of northern (Punjab, Rajasthan and Uttar Pradesh) and north eastern states.**
d. **Command areas in rabi/summer particularly under the Tungabhadra project where groundnut is grown during November to March.**

Benefit Statement Of PMG Technology

Several trials were conducted to estimate the benefits accrued through the PMG technology. It is obvious that introduction of a new technology involves certain capital expenses as well as operating expenses. The major cost involved in PMG technology compared to the non-PMG technology is the cost of the polythene film. The polythene film costs around Rs.2500 per hectare.

which is 10-12 percent of the total cost involved in PMG groundnut cultivation. Any new technology is a viable technology if the "benefit accrued outweighs the cost involved". The PMG technology fulfils the above dogma.

The PMG technology exclusively involves certain costs over the non-PMG technology. Besides cost of the film, the land preparation also involves certain cost for fine tilth, and bed preparation. But the benefits derived in terms of yield, water saving, weed control and certain non-monetary benefits like early germination, early maturity, etc outweigh the costs in manifolds.

The net returns per ha realized under the PMG technology was Rs.28795 compared to Rs.13785 under non-PMG. The cost benefit ratio was around 1:2.5 under PMG technology and 1: 1.7 under non-PMG technology. The benefits cost statements were presented in (Table 4.0). The net income obtained through the demonstrations under farmer's field was Rs.41380 under PMG technology and Rs.22080 under non-PMG technology **(Table 5.0).** Net income per ha is the best economic indicator which reflects the actual benefits accrued to the farmer and all the farmers tries to maximize this net income by adopting several cost reducing and yield enhancing technologies.

The scope for reduction of costs in adoption of PMG technology lies with the introduction of small multipurpose equipment to carryout functions like drilling seed cum fertilizer, spraying of herbicides and spreading of film together as used in China.

Table 4.0 Economics of Polythene Mulch Groundnut (PMG) Rabi/Summer Trials (Tamil Nadu)

I. Comparitive Benefit Statement

Sl.	Particulars of Expenditure	PMG (BBF)	Non-PMG No. (FlatBed)
	Input Cost (Rs/ha)		
1.	Hiring of Tractor/Bullock	1200	900
2.	F.Y.M	1500	1500
3.	Fertilizer	1500	1500
4.	Seed	4200	4200
5.	Seed Dressing Chemicals	200	-
6.	Plant Protection Chemicals	830	1130
7.	Herbicides	900	-
8.	Cost of film	2500	-
	Labour Charges (Rs/ha)		
1.	Land preparation	1100	275
2.	Spreading of polythene	675	-
3.	Sowing	1575	1125
4.	Fertilizer application	525	615
5.	Application of irrigation	550	1320
6.	Weeding/intercultural	-	2700
7.	Spraying of plant protection chemical	100	200
8.	Spraying of herbicides	200	-
9.	Harvesting	2250	2250
	Total	19805	17715
	Returns (Rs/ha)		
1.	Pod yield (q /ha)	27.00	17.50
2.	Gross return (@ Rs1800/q.)	48600	31500
3.	Cost cultivation (Rs/ha)	19805	17715
4.	Net return (Rs/ha)	28795	13785
5.	Benefit cost ratio	1 : 2.5	1 : 1.78

PMG = Polythene Mulch Groundnut
BBF = Broad Bed Furrow

Table 5.0 Economics of Polythene Mulch Groundnut (PMG) Demonstration during summer (Maharashtra)

II. Comparitive Benefit Statement

Sl.	Particulars of Expenditure	PMG (BBF)	Non-PMG No. (FlatBed)
	Input Cost (Rs/ha)		
1.	Land Preparation	1500	1500
2.	FYM	4000	4000
3.	Fertilizer	2220	2220
4.	Film	2500	-
5.	Herbicide	1000	1000
6,	Seed Cost	2500	2500
7.	Seed treatment	600	600
8.	Plant protection chemicals	2000	3000
	Labour Charges (Rs/ha)		
1.	Bed Preparation	600	600
2.	Spreading film	1000	-
3.	Weeding	200	1000
4.	Dibbling	1500	1500
7.	Harvesting	3000	2000
8.	Application of Irrigation	2000	3000
	Total	24620	22920
	Returns (Rs/ha)		
1.	Dry pod yield (q/ha)	44.0	30.0
2.	Gross Return (@Rs1500/q)	66000	45000
3.	Cost of cultivation (Rs/ha)	24620	22920
4.	Net profit (Rs/ha)	41380	22080
5.	Benefit cost ratio	1 : 2.7	1 : 1.96

PMG = Polythene Mulch Groundnut
BBF = Broad Bed Furrow

3. Package of Practice to Augment Higher Yields Through PMG

Fig 1. Verdant Green PMG Field

The PMG crop production technology involves intricate deeds. This also warrants certain accurate methods and specifications that are to be followed for enhancing groundnut productivity there by production in India.

The general package of practices to be followed for different regions and locations under PMG are presented below.

1. Land preparation

Groundnut requires fine tilth soil because its pod develops and matures inside the soil. Therefore, soil tilth has profound effect on productivity of groundnut. Deep tillage facilitates maintaining better crop stand, conserves soil moisture and ultimately gives higher pod yield.

a) Tilling of land

Land is ploughed with tractor or bullock drawn implements. The number of ploughing depends on the soil type as well as moisture levels during ploughing operation. The black soils require timely operation so that clod formation can be avoided. This clod formation hinders crop germination and there by affects plants stand and finally yield levels. So utmost care should be taken during land preparation to avoid difficulties in the later part of the crop growth.

Fig 2. Bed Formation (Bullock-drawn)

Fig 3. Bed Formation (Bed former)

b) Bed formation

Beds are to be formed after proper land preparation and levelling. While forming the bed, enough care should be taken to keep sufficient moisture in the soil. There are two types of bed preparation : 1)Flat bed and 2)Raised -bed with furrow method. The Raised bed and furrow system is most appropriate method to follow PMG technology.

The raised bed and furrow method of groundnut cultivation is a proven technology. The beds are to be formed at a width of 60 cm leaving 15 cm on the either side for the furrows. In a plot of 4.5m

width, five Raised beds can be formed. If the land is properly levelled, the length of these Raised bed and furrows can be extended to several meters depending on the size of the field. In sloppy land, bed should be prepared across the slope. These Raised beds can be prepared either by bullock drawn or by tractor drawn implements as seen in the Figures 2&3.

Care during preparation of raised beds

Based on the width of the polythene film the raised beds should be prepared. The beds should not be too high or too low. If it is too high there will be problem of complete coverage of beds by the polythene film. If the beds height is too low the extra film gathers in furrows reduces infiltration of rainwater into the soil profile. Both the sides of the bed should be almost vertical, the bed profile rectangular and the surface of the bed should be smooth without any clod or pebbles so that the film completely adheres to the soil surface.

3.2 Polythene sheet preparation

The ultra thin polythene sheet of 6-8 microns thickness with defined edges, and shape based on the raised beds width should be used. The perforations on the polythene for placement of seed can be made either before or after spreading the polythene sheet on the beds. A special instrument can be used for making perforations on the polythene sheet as shown in the Fig. 4, if the perforations are to be made before spreading the sheet on the bed.

Fig 4. Polythene Sheet Preparation

3.3. Manures and fertilizers

Once the polythene sheets are spread it becomes difficult to remove for performing any operation around plants rhizosphere, so the manures and fertilizers should be applied at the time of land preparation and mixed well in the soil before spreading the polythene sheets on the bed. Farmyard manure @12.5 t/ha and the recommended dose of NPK fertilizers should be applied as a basal dose in the main field. The entire dose of gypsum (400 kg/ha) should also be applied as basal as no after cultivation practices are possible in the PMG fields.

Fig 5. Herbicide Spraying Through Sprinklers

3.4 Pre Planting Herbicides

In the areas where weed menace is more, Fluchloralin or Pendimethalin, the pre-planting herbicide @1.0 kg ai/ha may be sprayed in the mainfield before spreading the polythene films. If the field size is large the herbicides can also sprayed through sprinkler irrigation system as shown in the Fig. 5.

3.5 Spreading of polythene sheet

The polythene film should be spread on the Raised beds so that the film completely adheres to the soil surface. The edges of the film should be properly buried on either side of the raised bed so that the film is not blown away by the wind.

3.6. Seeds and sowing

Mature and healthy seed is a pre-requisite for establishment of optimum plant stand of crops in the field. Poor plant stand contributes significantly to low productivity in groundnut. About 30% of groundnut seed sown in the field will either not germinate or after germination fail to establish into healthy plants due to low seedling vigour.

The effect of seed size of groundnut on germination, seedling vigour and pod yield have been widely reported and it is now well established that medium size of groundnut seed should be used for seed purpose. Besides seed size, degree of seed maturity has profound effect on establishment of plant stand and pod yield of PMG groundnut. The sowing of medium maturity class seeds will result in higher percentage germination, better growth and improved pod yield. Thus for optimum and uniform plant stands, medium maturity class of seed should be used for sowing groundnut to realize higher productivity.

Seed Treatment

Seed treatment with fungicide

There are several seed and soil borne fungal diseases of groundnut, which cause considerable damage to the seed before seedling emergence, and subsequently to the emerged seedlings. To control seed borne diseases, groundnut kernels should be treated with mancozeb (3g/kg seed) or carbendazim (2g/kg seed). Seeds should be treated atleast 7 days before sowing.

Seed inoculation with microbial culture

Certain microbial strains like rhizobium assist groundnut crop to fix nitrogen from the atmosphere. These microbial strains are also called "fertilizer factories" in the soil.

Groundnut being a leguminous crop can fix atmospheric nitrogen through symbiotic process by Rhizobium bacteria present on the root system. Seed inoculation with efficient strains of Brady rhizobium can substantially augment the nitrogen requirement of groundnut crop grown under PMG technology. However phosphorus requirement is quite high of groundnut crop and it can be supplied by application of phosphate solublizing microbes (PSM). The Seed inoculation with plant growth promoting rhizobacteria (PGPR) also helps in increasing nutrient use efficiency in groundnut.

3.7. Seed rate & Spacing

100 kg kernel/ha seeds should be sown such that 20 cm inter plant and inter row spacing is maintained uniformly. Two seeds are sown by dibbling method in each pre-designed perforation such that 33plants/m^2 is maintained uniformly in the minefield shown in the Fig. 6.

Fig 6. Plants Under Optimum Spacing

3.8. Depth of sowing:

Depth of sowing affects seedling emergence, plant growth and finally pod yield of groundnut. Deeper sowing reduces germination and increases hypocotyls length, which results in lower pod yield. Shallow sowing (2.5-5.0 cm) is advantageous for higher pod yield compared with deeper sowing (7.5-10.0 cm).

3.9. Weed management

Weeds are called **'plants out of place' or 'unwanted plants'.** These weeds compete for moisture, nutrients and space along with the groundnut crop and drastically affect crop germination, crop stand, growth and yield. Some studies report that 80 -100 % yield loss is recorded if weed growth is not properly checked at the appropriate stage.

The growth of some of the dominant annual and perennial weed flora will be suppressed due to **"smothering effect"** if groundnut is grown under PMG technology. The principle behind this suppression is due to increase in the soil temperature below the polythene much and also non-

availability of sufficient photoperiod for weeds to grow besides physical suppression by the polythene sheet. This increase is due to partial reflectance of the incoming radiation by the polythene mulch.

3.10. Water management

The groundnut crop requires on an average 400-500 mm of water under normal conditions. Optimum availability of water at critical stages of crop growth like flowering, pod filling and maturity enhances yield levels substantially. Sprinkler irrigation is the best method for irrigating PMG fields.

Around 40-50 % of water irrigated to groundnut crop is lost through evaporation and percolation losses. This **"wasteful process"** like evaporation can be drastically be reduced under PMG cultivation. Besides **'saving water'** this technology has several ecological implications especially in recent years where ground water exploitation is increasing at an alarming rate.

Fig 7. Sprinkler Irrigation

11. Pests and diseases management

The maximum exploitation of groundnut crop is by the sucking pests like jassids, aphids and thrips during the early stage of crop growth. Several experiments conducted under PMG technology shown complete freedom from these pests. Some of the soil borne diseases like color rot, stem rot, dry rot and damping off incidence also mitigated under PMG technology.

12.Harvesting

The crop matures 7-8 days before the normal crop. Harvesting can be done manually or with bullock drawn harvester as shown in the Fig. 8. The seeds can be separated from the harvested plants using the seed thresher as shown in Fig. 9.

Fig 8. Bullock Drawn Harvester

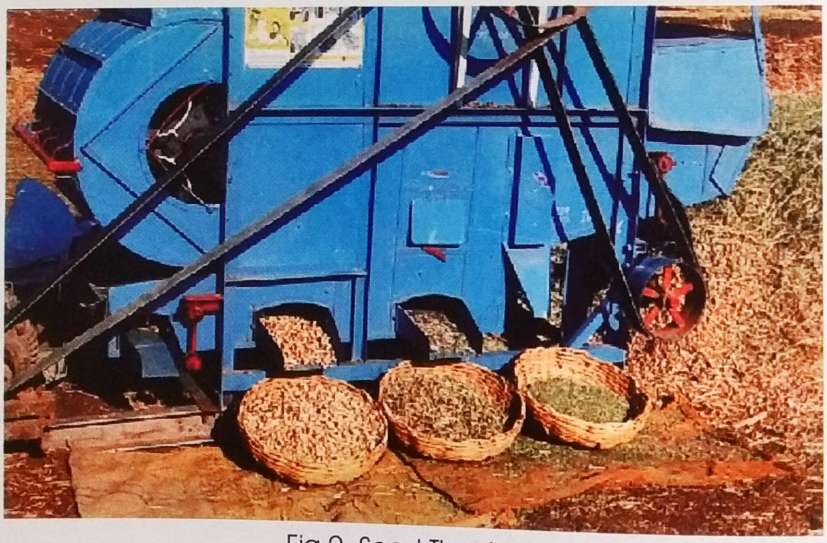

Fig 9. Seed Thresher

Water Crisis

The major crisis expected in future in India is **'water crisis'.** With the ever-growing population coupled with mis-utilization of the existing water resource are the major reasons quoted for this crisis. In recent years the monsoon failure is a common phenomenon, if this continues it will threaten food security and livelihood security of millions in India. In this imbroglio, the main weapon in the hands of Indian farmers is adoption of water saving technologies. Since PMG technology is the initial and innovative step, it can be better used by the groundnut growing farmers. Besides this, the lessons drawn from PMG technology will be useful for the policy makers to derive suitable strategies to increase and also stabilize production levels in other crops like cotton, sunflower, maize etc with the available water.

In future the concept of **"productivity per ha"** should be relegated and the **"productivity per cubic meter"** need to be given prime importance.

4. Benefits and Reasons of Yield Increase Under PMG Technology

Rapid germination and early vigour

There is spatial and temporal variation in groundnut cultivation in India. The germination is affected if the soil temperature goes below 18°C especially when groundnut is grown during winter months. During these months the polythene mulch induces heat and create conducive environment (micro- climate) for rapid germination and early establishment of seedlings.

Soil moisture retention and prevention of soil erosion

The water is an inevitable input during the critical stages of crop growth. The PMG technology saves 40-50 % of total quantity of water used by protecting the soil from evaporation losses. **If one considers 50% of irrigation is saved under PMG technology, the current rabi / summer area** (1.2 million ha) **under groundnut can be doubled (2.4 million ha) with existing water use levels.** Besides, during the heavy rainfall, the polythene mulch prevents the soil from direct impact of water droplets and thereby **'soil erosion'** and **'nutritional losses'**.

Soil microorganisms

The Dalian Agricultural Research Institute (China) reported that the number of microorganisms goes up significantly under PMG. The fungi increases by 58%, actinomycetes by 36%, ammonifiers by 25%, nitrogen fixing bacteria by 47.3%, phospho bacteria by 56% compared to non- mulched groundnut fields. Under Indian condition, the PMG trials conducted at Akola (Maharashtra) reveals the fungi increases by 48%, bacteria by 41% and actinomycetes by 29%. The increase in microorganism's load increases the rate of decomposition and transformation of organic matter in the soil. Thus the availability of nutrients to the crop is ensured.

Less weed number and weed dry matter

Due to smothering effect the sunlight and space availability to weeds is curtailed. Due to this effect the weed population and its dry matter is reduced drastically.

Freedom from sucking pests

Sucking pests are the early entrants to damage the crop. The polythene mulch shows **"glittering effect"** by reflecting the sunlight. Hence, sucking pests are driven and their by attack on the crop is minimized.

Minimal disease and pest incidence

Weeds act as an abode for most of the pest and diseases that attack groundnut. Since the weed growth is prevented under PMG technology the disease and pest incidence will be lower in polythene mulch groundnut. The sclerotial rot disease incidence was less (0.52%) in PMG trials compared to non-PMG conducted at Akola (Maharashtra). The results are presented below

Treatment	Disease incidence (% Root rot)
1.Polymulch+Seed treatment	0.52
2.Non-Polymulch+ Seed treatment	1.37
3.Polymulch+ No Seed treatment	2.56
4.Non-Polymulch+ No Seed treatment	3.85

Vigorous crop growth and higher flower to peg ratio & mature peg to pod ratio

Due to the above said factors like conducive microclimate, symbiotic effects of micro organisms, less weed growth, free from sucking pests attack, the vigorous crop growth is achieved and subsequently the flower to peg ratio as well as peg to mature pod ratio is higher under PMG technology.

Non-monetary benefits

Due to early growth and maturity the PMG groundnut fits well into the existing cropping pattern for several locations of India. Besides this utilization of residual moisture and nutrients under rice fallow situation etc are some of the non-monetary benefits derived through PMG technology.

Ecological implications of PMG technology

The per capita consumption of plastics in India has grown from 0.5 kg per ha in the early 80's to 4.0 kg per ha in 2000. This is a significant growth when compared to population growth. The life without plastics is unimaginable. In recent years the plastics use in different sectors has drastically increased especially in agriculture. However, several bio-degradable plastics are also in the offing and it is not far off in commercially utilizing them. This will not only protect the soil and but also the environment in a sustainable way.

5. Luminary of PMG Technology in India

Technology **generation** and **implementation** are like the left and right foot required for swift walking. Though, PMG has been generated in China, the implementation became a reality only due to untiring efforts of DR. M.S.Basu (Director NRCG & formerly Project Co-ordinator AICRIP-G). He made sojourn visit to China and returned back with full hope to do research on PMG technology. Consequently, he approached IPCL to manufacture the polythene film of 5-6 micron for PMG research. Later DR. M.S.Basu actively engaged himself in co-ordinating activities with several centers/agencies for PMG implementation besides his hectic work as All India Co-ordinator and Director, NRCG. Stumbling blocks he faced did not deter him in making his mission success. He along with his peer scientists conducted several trials and also demonstrations across different locations and situations of India and unveiled the hidden potential of groundnut yield.