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Oilseed Crops for Spate Irrigated Farming in Pakistan

Practical Notes Spate Irrigation

Spate Irrigation Network pakistan

1. Local production and import of edible oils

Pakistan is unable to produce edible oils sufficient for domestic needs of 2.78 million tons, out of which local production is 0.83 million tons. The gap is bridged through import of edible oils of 1.9 million tons (68% of demand) worth of Rs. 111 billion during 2007-08. The increase in import of edible oils is 6.6% per annum since 1991-92. Cottonseed contributes 51% of domestic oil production; sunflower is the second important crop contributing about 32%, while Canola, rapeseed and mustard are contributing 17% (GOP 2008).

Pakistan was self-reliant in edible oils till the 50s, when it met requirement. It started importing edible oils to supplement domestic production, which was increased in the mid 70s, as 41% of total consumption was imported in 1974-1975. At the same time, the canal water supplies had increased to 105 MAF against 64 MAF at the time of independence. This increase is attributable to the storage reservoirs of Mangla, Chashma and Tarbela which became operational in 1967, 1971 and 1976, respectively (Afzal 1996). The increased water availability resulted in the adoption of high delta crops (cotton, sugarcane, fruits and vegetables) and area under oilseeds was reduced drastically. Share of domestic production in consumption has been declining because of very slow growth of production against considerable increase in consumption. There are many supply factors as well as demand side factors responsible for the deficit in edible oils. On supply side, low growth of edible oils production can be attributed to the following factors:

- **Competition of oilseeds on water with cash crops in the Indus Basin**
  There has been almost no growth (< 1.0%) of oilseeds in last 37 years (GOP 2006; GOP 2008). Rapeseed, mustard and Canola being major oilseeds compete with wheat for limited water supplies. Wheat requires 24 MAF of canal water out of total of 31.4 MAF available in Rabi. Very little water is available for other Rabi crops including oilseeds. Wheat average yield is 2.45 tons/ha against rapeseed and mustard yield of 0.83 tons and Canola of 1.24 tons/ha (GOP 2008). Farmers prefer to grow wheat, as it is not only a staple food but have higher economic returns both from grain and straw.
- **Lack of technological advancement and in-efficient machinery**
  Lack of appropriate technology and in-efficient harvesting and extraction machinery are the major factors contributing to low productivity and inefficient extraction of oil. Crop losses at the time of harvesting and during extraction reduce oil production. Low productivity of oilseeds is largely due to shortage of water. Yields are in the range of 15-46% of the potential. Although, safflower, Sunflower and Canola are showing relatively good yield, they are still giving less than half of its potential yield due to in-efficient production technology, lack of improved seed, inadequate water and in-efficient harvesting and extraction techniques.
- **Non-supportive government policies**
  Low production of oilseeds can be attributed to the neglect of effective policy support for local production and import of edible oils. This follows from the fact that cotton, which is a fiber crop, remains a dominant source of domestic edible oil production despite being crop with low oil contents and now residue of pesticides have been detected in cotton seed. Sunflower has higher oil contents, high yielding and gives higher returns (GOP 2006; GOP 2008). Oilseed growers face lower market prices that dampen down production. Farmers prefer to grow other crops because of sound procurement system. Marketing system should not allow importers to exploit local producers, as it is a usual practice of importers to decrease the market prices of imported edible oil as the maturity period of crops approaches (Sumia, B. Z. et al. 2009).

2. Can Pakistan be self reliant in edible oil

Currently, the production gap is about 1.9 million tons. Total requirement of edible oils is projected with 3.76% growth rate and production is projected with 4.0% growth rate[1]. Total requirement of edible oil is projected at 5.36 million tons by 2030 while projected level of production is 1.98 million tons and the gap is 3.4 million tons. Self-sufficiency in edible oils may not be possible in the short run but in the long-term the prospects seem reasonable.
The key factor is to increase the area under oilseeds outside the Indus basin. Currently, only

1) This is an avarage growth rate from 1990 to 2008

0.83 million ha is under oilseeds, whereas to achieve self sufficiency in edible oils increase in the area to 3 million ha is required (Sumia, B. Z. et al. 2009).
It is possible to introduce oilseeds in spate irrigated areas, where these crops suits well as their water requirement is less than wheat and they perform better even in dry spells. There is a large contingent of oilseeds that proved to be promising for spate irrigated areas including rapeseed, mustard, Canola, sunflower, safflower, sesame and linseed. Canola, a promising oilseed with high yield potential, can also be grown in spate irrigated areas having potential of 2 or more irrigations. The olive plantations in temperate climates of Balochistan and part of NWFP would not only produce edible oils, but it would also provide surface cover (Chaudhary et al. 1998). The opportunities are illustrated as under:

- Spate irrigated areas are ranked second to the canal irrigated areas. Water efficient crops like safflower, rapeseed and mustard, linseed and sesame can be grown in these areas where wheat can't be grown economically.
- Canola and sunflower can be grown in spate irrigated areas where 2 irrigations can be provided to these two crops and with contribution of rainfall a bumper crop can be harvested.
- As price of oilseeds is fluctuating in the market and there is no assured procurement of oilseeds by the public sector in-line with wheat, therefore farmers can be organized in to a cooperative to extract edible oil and market the oil to fetch comparatively higher returns.
- Policy support can motivate local farmers and industry for local production of edible oils.

3. Production Technology for Oilseeds

Many oilseeds are grown for production of edible oils and can be grouped in two categories: a) conventional oilseeds; and b) non-conventional oilseeds. Rapeseed, mustard, groundnut and sesame are conventional oilseeds and are being grown since historical times. Sunflower, soybean and safflower are non-conventional crops and are recent introductions. There are oilseeds for industrial uses - linseed and castor. The recommended production technology for different oilseeds in Pakistan (NARC 2007) was reviewed and based on the experience gained under the "National Spate Irrigation Project" the following potential crops have been selected to grow in spate irrigated areas.

3.1. Rapeseed and Mustard

Rapeseed and mustard are important species of Brassica grown as oilseeds. These have remained one of the major sources of edible for centuries. Presently, five Brassica species are cultivated as field crops. Among them, existence of "Sarson" (*B. campestric*), "Raya" (*Bjuncea)* and "Taramira" (*Eruca sativa*) goes back to centuries. Introduction of B. napus (*Gobhi sarson*) is rather recent and its cultivation as a seed crop is confined to Barani areas of NWFP and Punjab.

It is sometimes grown as a mix crop with wheat and fodders. Another newly introduced species, *B carinate* (Ethiopian mustard) is fast coming up as a high yielding, aphid and drought tolerant type which is suitable for spate irrigated areas as well as Barani conditions.

All types of soils are suitable for rapeseed and mustard except waterlogged soils. For the purpose of seedbed preparation, 2-3 ploughing and 1-2 planking are recommended. The planting time in spate irrigated areas would vary significantly in different provinces. In Northern Punjab, recommended planting time is October. In southern Punjab, Sindh and Balochistan, crop can be planted from mid October to mid November. In NWFP, crops can be planted from mid September to mid October.

The recommended seed rate for line sowing is 4-5 kg/ha, whereas for broadcast it is 5-6 kg/ha. Row to row distance recommended for planting is 30-45 cm; whereas plant to plant distance is 4-5 cm. Seed depth of 2-3 cm is recommended. Farmers of the spate irrigated areas hardly use any chemical fertilizer because every spate flow brings sediments and addition of chemical fertilizers sometime result in to lodging. However, in areas where fertility is low, fertilizer dose of Nitrogen of 46 kg/ha and Phosphorus of 46 kg/ha is recommended. Potash is not needed as the

Figure 1. Rapeseed grown in Spate irrigated and Barani areas.

sediments brought sufficient potash with water.

A deep irrigation before planting to provide moisture for crop establishment, and one additional irrigation at bud initiation or flowering can provide potential yield coupled with rainfall in later part of the growing season to have economical harvests.

Aphid is the major insect and it can be controlled using spray of Dimecron at the rate of 500 ml/ha or Primore at the rate of 625 gm/ha. Crop matures in 180-190 days and it can be harvested when 30-40% seeds mature and turn brown in the main stem. Threshing can be done after sundry of harvested materials for 8-10 days. Dry seed to maintain 8-10% of moisture and then can be stored at dry places.

The potential areas of spate irrigated farming are spread in all provinces and it can provide opportunity to grow these crops even in dry years when economical harvest of wheat is not possible. The common insects and pests of rapeseed and mustard along with mode of damage and possible control measures are given in Table 1. The common diseases and measures for their control are presented in Table 2.

3.2. Sunflower

Sunflower is the major oilseeds grown in the country for production of edible oils. It is cultivated on an area of 397,306 ha during 2007-08. The average yield is 1.52 tons/ha during the same year. It is largely grown in irrigated area and very little effort has been made to grow it in spate irrigated areas. It

Figure 2. Sunflower grown in the field with full flowering

is a potential crop for spate irrigated areas. Its expansion since its introduction remained restricted due to the absence of systematic market mechanism, non-availability of quality seed and poor adaptability of imported hybrids. However, with time and introduction of improved production technologies and hybrids, productivity has been increased to 1700 kg/ha which is comparable with other countries. Major sunflower growing areas in spate farming are Rajanpur and Layya in Punjab, Sibi and Lasbela in Balochistan and D.I. Khan in NWFP (Figure 2).

Two crops of sunflower (spring and autumn crops) can be grown in spate irrigated areas based on availability of spate flows. The spring crop in spate irrigated areas can be grown during December to February depending on temperature. In cooler areas crop is normally grown in February, whereas in southern areas of Punjab and Sindh it is grown during December and January. Similarly, the autumn crop in spate

Table 1. Insect and pests of rapeseed and mustard crops and their control ilitation of three drinking water ponds in DI Khan

Common Name	Mode of damage	Control measures		
		Cultural	Chemical	Biological
Cut Worm	Cut young seed-lings; affecting stand establishment	Digging at day time strong ridges and sanitation	Thimet 10G Paramet 50EC	Egg and larval parasitoids; Application of Bacillus thuringiensis
Flea Beetle	Make holes in leaves		Karate 2.5 EC Bidrin	
Cabbage Looper	Leaves		Kilyal, Padan Trebon	
Turnip Aphioh	Sucking cell sap from leaves and floral parts	Resistant varieties; yellow coloured traps	Folidol, Monitor Pirimor, Karate	D. rapae, Coccinilids, *Chrysoperla carne* Syrphids, Mencohilus sexmaculatus

Table 2. Diseases and their control measures for Rapeseed and Mustard

Disease	Control measures
White Rust	Use of resistant varieties. For control of primary infection, destroy previous year's crop residues. For secondary infection spraying with fungicide like polyram, curpravit 3-4 time, during season 1.5 liter/ha @ 200 gm/100 gd.
Alternaria black spot	Fungicide sprays: Polyram (500 gm/ha) or Deconil (1.7 – 2.3 kg/ha). Soaking seed in hot water at 54°C for 10 Minutes. Early sowing help in escape crop form disease.
Sclerotia stem rot	Phyto sanitary measures: Destruction of diseased plant debris. Seed cleaning and long rotation. Fungicide sprays; Foliar sprays with Topim M 90.7 – 1 kg/ha for secondary infection

irrigated areas can be grown during July and August depending on availability of soil moisture for crop establishment. Planting season in spate irrigated areas is subject to the availability of soil moisture for crop establishment. Crop is planted using drill or manually but strictly in lines due to higher cost of hybrids. The recommended seed rate is 5-6 kg/ha. Row to row spacing is 75 cm, whereas plant to plant spacing is 25 cm.

Sunflower is exhaustive in depletion of nutrients. Chemical fertilizers are recommended if soils are depleted, where nitrogen at the rate of 75 kg/ha and phosphorous at the rate of 50 kg/ha can be applied. Potash is not required as floodwater has sufficient potash. In case soils are deficient in potash, application at the rate of 50 kg/ha are recommended.

Two deep irrigations after crop establishment supplemented by rainfall provide good harvest of sunflower. spate water requirement of spring crop is higher than autumn, largely due to higher rainfall. Successful weed control should include a combination of cultural and chemical methods. Harvest the crop when back of heads turns yellow and bracts brownish. Dry the harvested materials for 4-5 days and thresh with sunflower thresher. For storage of sunflower seed 9.5 % moisture is considered suitable.

The potential areas include D. I. Khan, D. G. Khan, Dadu, Sibi, Lasbela and Kalat, where sunflower can be grown under spate irrigated farming. The common weeds in sunflower crop are listed in Tables 3 and 4 for *Kharif* and autumn season, whereas common diseases and control measures are listed in Table 5.

3.3. Safflower

Safflower had been grown for centuries as a source of dye, medicine and human food. It did not gain any attention as an oilseed crop and has remained neglected. As an oil crop, it was introduced during mid 60s and since then it has been grown on very small area in Sindh. During the last decade it has been planted on an area of around 1000 103 ha. The maximum area planted under safflower was 8,100 ha in 1982-83 and then started declining. The efforts did not become fruitful because the crop was not taken up by the farmers of Punjab. Although, average yield of safflower was high, to the level of 1.1 tons /ha in 1985-86, but it could not make a place in the system. Major constraints to production are: a) spiny nature of the crop; b) lack of high yielding varieties; c) competition with other winter crops; d) long duration for crop maturity; and e) lack of seed dormancy due to which the mature seeds gets germinated in heads before harvesting. Now spineless varieties are available, therefore, there is a potential to consider this crop for spate irrigated areas primarily because of low water requirement.

Safflower can be grown on all types of soils except waterlogged and acidic soils. For the purpose of seedbed preparation 2-3 ploughings are needed followed by 1-2 planking. The planting time for northern Punjab is the whole month of October, whereas in southern Punjab, it is planted during mid of October to mid of November. In NWFP, it Is planted during mid September to mid October. In Sindh and Balochistan, the crop is planted during the period of mid October to mid November. Seed rate of 15-18 kg/ha is used for line sowing but for broadcast it increases to 22-30 kg/ha. Row to row distance of 45 cm and plant to plant distance of 10-12 cm is recommended.

Seed depth is maintained at 2-3 cm. In spate irrigated areas receiving lot of sediments no chemical fertilizer is needed.

However, in areas where fertility is low 50 kg each of nitrogen and phosphorous is needed. The crop matures in a period of 170-180 days. Harvesting is recommended when 30-40% seeds mature and turn brown in the main stem. There is a need to sundry the crop harvest for a period of 8-10 days and then threshing may be started. Drying of seed is required to achieve moisture level of 8-10% and store at it in dry place.

Table 3. Weeds affecting sunflower during the *Kharif* season

Common Name	Classification of weed	Control measures	
		Mechanical	Chemical
Batho	Broad leaves	Hand weeding	Stomp 0.1-105 lit/acre
Tandla	Broad leaves		
Deela		Rotary weeder	Dual gold as pre emergence
Baroo			
Pohlie			

Table 4. Weeds affecting sunflower during the Spring season

Common Name	Classification of weed	Control measures	
		Mechanical	Chemical
Khabbal	-	Hoeing	Stomp @1-2 lit/acre
Lihli	Broad leaves	Rotary weeder	As pre emergence
Jangli Haloon	Broad leaves	Hand weeder	Dual gold @ 800 ml/acre
Dramp	Broad leaves	With khurpa and sickle	As pre emergence
Pohlie	Broad leaves		Ronstar @ 1 lit/acre as pre emergence

Table 5. Diseases and their control measures for Sunflower

Disease	Control measures
Charcoal rot	Use of resistant varieties, cultivate early maturing varieties, stress to the crop and irrigate field near maturity. Rotation reduces losses. Proper scheduling of irrigation of time at flowering and seed formation is important. Seed treatment with Tecto @ 2.5 g/kg help in reducing primary infection from seed
Head rot	Avoid injury to head from insects or mechanical. Screening for resistant variety can also prove as a good control management strategy. Bird damage should be prevented. If insect are predisposes, suitable insecticides should be sprayed.
Alternaria Leaf spot	Fungicide sprays: Polyram (500 gm/ha) or Deconil (1.7 – 2.3 kg/ha). Soaking seed in hot water at 54 °C for 10 minutes. Early maturing varieties help in escape crop from disease.
Collar rot	Use of resistant varieties is the only control management.

The Potential areas for this crop are Sindh and Balochistan, but it can be easily grown in other provinces. The common insects and pests along with mode of damage caused by these insects including the control measures are listed in Table 6. The common diseases and control measures are presented in Table 7.

Table 6. Insect and pests of safflower and their control

Common Name	Mode of damage	Control measures		
		Cultural	Chemical	Biological
Safflower fly	Making tunnels in stem		Ripcord	
Thistle Aphid	Leaves by sucking cell sap	Resistant varieties	Krate, Monitor, Orthene	Predators, Chrysoperia carnea. Coocinilids
Lucern caterpillar	Leaves		Karate, Thiodan Ripcors, Cyperguerd	Trichogramma chilonis, Telenomus remus Cotesia spp.

Table 7. Diseases and their control measures for Safflower

Disease	Control measures
Alternaria & Remularia leaf Blight	Crop rotation
Bacterial Blight	Crop rotation and Disease resistant varieties
Rust	Crop rotation and Treatment of Seed @ 3 gm / kg with Thrim
Root Wilt	Crop rotation Avoid over irrigation

3.4. Linseed

Linseed cropped area has been fluctuating from 5000 to 9000 ha in the last decade. It is grown both for oil and fiber crop. However, it is used mainly for non-edible purposes. In Pakistan it is grown in Sindh and Punjab. Its area and production has been stagnant. Maximum area of linseed was 12525 ha during 1978-79. The current average yield is 670 kg/ha (Figure 3).

The recommended soil is sandy to loamy sand, thus it can be grown in light textured soils and thus it is not feasible to grow in areas inundated for longer times in spate irrigated areas. For the purpose of seedbed preparation, 2-3 ploughings are needed followed by 1-2 planking. The recommended planting time is from 1st October to mid November. The recommended seed rate is 15-25 kg/ha based on type of planting. Less seed is required for line sowing, whereas more seed is required for broadcast. Row to row spacing of 45 cm and plant to plant distance of 5-7 cm are normally observed. Seed depth of 2-3 cm is maintained in the field.

Figure 3. Linseed crop grown in the field

Farmers receiving sediments with spate flows do not require any chemical fertilizer, because all nutritional requirement are met from sediments. However, in soils having low soil fertility might require 50 kg/ha of phosphorous (P_2O_5). Nitrogenous fertilizers are not required otherwise severe lodging will be observed.

Crop matures in 170-180 days and can be harvested at physiological maturity, otherwise shattering may be common. The harvested material must be sun-dried for 8-10 days and then threshing can be done. Afterwards, the seed need to be dried to maintain 8-10% moisture and then store it at dry place. The potential areas are spread all over the country but it is commonly grown in Punjab and Sindh.

3.5. Sesame

Sesame or "Til" is the most ancient crop being cultivated in the sub-continent. Its seeds contain between 50 and 58% semi-drying oil. Oil is used as foods (cooking and salad), medicine and soap manufacturing. Its seeds and young leaves are eaten as stews. Honduras and Egypt are leading countries producing yield of 1267 and 1063 kg/ha, respectively. In Pakistan, the average yield

during 2007-08 was 429 kg/ha because largely it is grown in Barani areas. The yield potential will be higher in spate irrigated areas. The area under sesame during 2007-08 was 76,400 ha, which has been reduced from maximum of 135,600 ha during 2001-02.

The yield potential of "Til" cultivars is up to 2000 kg/ha. The spate farmers can have higher potential due to availability of spate flows and nutrient rich sediments. Spate farmers must increase area under sesame and adopt technology to boost productivity and meet demand of sesame in the country (Figures 4 and 5).

Light sandy and medium loam acid free soils are more suitable for sesame. For seedbed preparation 2-3 ploughings followed by1-2 planking are required. Planting in Punjab is made during whole of July. In Sindh, it can be grown from mid June to mid July. In NWFP, it can be grown from mid June to the end of July. It can be planted in whole of the month of July in Balochistan. Seed rate of 5 kg/ha is recommended for line sowing and 8 kg/ha for broadcasting. Row to row distance of 45 cm and plant to plant distance of 10 cm are suggested. Chemical fertilizers are normally not required for spate irrigated areas receiving nutrient enriched sediments, otherwise lodging is observed.

In depleted soils, nitrogen and phosphorous at the rate of 50 kg/ha is recommended.

One deep irrigation after planting followed by incident rainfall can mature sesame crop with a reasonable yield. Two to three light irrigations can provide higher yields. The crop is drought tolerant therefore excessive moisture is not recommended.

After 10-15 days single out the weak and diseased plants by keeping 10 cm spacing between plants. Two hoeing are recommended first at 15-20 days and second at 30 days after crop germination.

Sesame matures in 100 to 120 days. Harvesting can be done when 75 % capsules are matured and turn yellow. Stack bundles keeping the pods upward. The harvested material is kept for a week and then threshing is made. The potential areas are located all over the country and sesame can be grown in spate irrigated areas, as it is a crop which is of low water requirement and economical to grow, as the demand is now increasing. The common diseases of sesame and recommended control measures are presented in Table 8.

Figure 4. Sesame crop at flowering stage in Spate irrigated areas

Figure 5. Sesame crop at harvesting stage in Spate irrigated areas

Table 8. Diseases and their control measures/management for Sesame

Disease	Control measures
Bacterial Blight	- Healthy Seed - Treatment of seed with 0.3% Thrim - Spry the field with Dithene M-45 or Tacto or Banlate @ 500 gm/acre
Root rot	- Healthy Seed - Treatment of seed with 0.3% Thrim - Spry the field with Dithene M-45 or Tacto or Banlate @ 500 gm/acre

3.6. Castor

Castor is an important industrial oilseed and its oil is used in over 300 derivatives for use in soap, cosmetics, pharmaceutical, paints, varnishes and lubricants in high-speed jet engines. Pakistan imports castor oil for use in automobile industry.

Castor is successfully cultivated in tropical and sub-tropical regimes. Pakistan is situated in semi-arid to hyper-arid climates. Castor being drought tolerant can be cultivated in areas deficit in water. Its tap root penetrates to a depth of 1.5 to 3 m (Figures 6 and 7)

Castor crop matures in 120 to 150 days. First picking is in November and/or December, second picking is in January and February and third picking is in March. There are three major varieties: a) C-3; b) US-1; and c) DS-30. The genetic potential of DS-30 is 1.5-2.0 tons/ha.

Castor is a remunerative crop of spate irrigated areas. Castor seed contains 50-55% non-edible oil and 26-30% protein. Due to the nature of chemical composition, its oil is used in over 300 derivatives. Castor is cultivated in Punjab, Sindh and Balochistan on an area of 3567 ha in 2007-08 and yield of 622 kg/ha. The major area is in Lasbela District. However, more area suitable for its cultivation under semi-arid region can be explored and utilized. Nevertheless, castor is not suited to saline soils.

Soil with pH ranging from 5 to 6.5 is suitable for castor germination. Sandy and loamy soils are preferred for its cultivation. Planting time is March to April for spring crop and July to August for autumn crop.

Seedbed preparation requires 2 – 3 ploughings followed by 1-2 planking. Seed rate varies between 5-10 kg for line sowing depending upon availability of water. Row to row distance is 1.22 m and plant to plant distance is 1 m. The seed depth has to be maintained at 2-3 cm.

Chemical fertilizer is not required in spate irrigated areas due to heavy inflow of sediments enriched with nutrients. In depleted soils 25 kg of nitrogen and 50 kg of phosphorous are recommended.

Crop matures in 120-150 days. The seed has to be harvested and then dried to maintain 8-10% and then store it at dry places.

Figure 6 and 7. Castor oilseeds varieties grown in field

Figure 8. Mustard seed broadcasted widely

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Colofon

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