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Strategies for enhancing linseed production for self sufficiency in oil & industrial demands

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Linseed (*Linum usitatissium* L.) is an important oilseed crop grown almost every part of the country. Traditionally cultivated for oil meant for edible as well as industrial purposes. Almost every part of its plant is commercially utilized either direct or after processing. On small scale, the seed and its oil are directly used for human consumption as flax seed breads, bagels and other baked and fried food stuffs. Linseed is highly nutritious. It is a source of complete protein (all 8 essential amino acids), high order linolenic acid (an essential polyunsaturated Omega-3 fatty acid), complex carbohydrates, vitamins and minerals. Recent advances in medical research have found linseed as best herbal source of Omega-3 and Omega -6 fatty acids which have immense nutritional/ medicinal effect on human body. Now a days, this crop is emerging as very good source of nutrition special reference to having ample amount of Omega-3, which is a cheap and best source of essential nutrition for pregnant women, children and all category of human beings. Its cake is a very good source of cattle feed for production and nutrition point of view. The state contributed 56 % both in area and production of the country which proved Madhya Pradesh is the major state as regard area and production of linseed crop.

Scope of increasing area with cropping system and crops to be replaced

The area, production and productivity is lowering in the region, state and also in country. The problem of decreasing the area, production and productivity can be solved by using high yielding, multiple resistant varieties for different biotic and abiotic stressess. At present, number of improved varieties namely JLS-9, JLS-27, JLS-66, JLS-67, JLS 73, JLS 79 and

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JLS 95 have been developed by the centre having high seed & oil yield but the extension of the transfer of technology is very poor. Hence, ultimate users are not being benefited. The conduction of large numbers of front line demonstrations of improved varieties may be a effective tool to convince the cultivators by implementing higher production technology. Although, we have developed good varieties maturing within 110-120 days which is suitable to fit in double cropping system after paddy, soybean, maize, urd and mung as per the requirement of the cultivators. The area under crop is being increased gradually since last four years and this trend will continue due to lower input cost crop coupled with high market premium and early maturing varieties. Secondly, its area can be enhanced through adopting linseed as an intercrop with major crops of the state viz, Wheat, gram and lentil. Thirdly, it possesses least abiotic risk especially able to give 70-80 % yield even after heavy flush of frost hence, there is no another crop is being grown during rabi season with having such tolerance ability against frost. Lentil, lathyrus, pea, gram and even rainfed wheat can easily be replaced by this crop owing to low input technology crop, most suitable under adverse environmental conditions (biotic and abiotic stresses), rich in omega 3 and fibre quality it always having very attractive market premium.

Short term strategies for area expansion:

With securing the availability of foundation, certified seed and large scale varietal as well as intercropping demonstration of improved varieties could play significant role in area expansion and adoption of linseed as low input cost technology as compared to wheat, gram, lentil lathyrus and wheat in rainfed and semi irrigated area of of the state. In the region pulses occupied a sizeable area and heavily affected by wilt disease. Intercropping of linseed with pulsed could help in minimization of wilt problem in pulses. By the use of high yielding multi-resistant and short duration varieties of the linseed, cultivators will be benefited on the one hand and varieties containing high level of oil and quality, industrialist will also be benefitted on other hand by getting good nutritive raw material for their industries especially Omega-3 as a medicine and used . Its fiber is also very useful in making cloths (lenin), ropes and being used in making parashoot, very good matrix for making plywood and other hardboards . More than 80% of its oil is being used in paint and varnish industries owing to its fast drying property.

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Long term strategies for area expansion:

Cultivar development of linseed is currently focused on early maturing and enhancing the oil content and nutritional value to meet the demand of nutraceutical market supply, as an alternate source of fish oil, flax is the richest source of ALA, a precursor for the synthesis of very long chain polyunsaturated fatty acids (VLCPUFA), a rich source of eicosapentaenoic acid (EPA, C20:5) and docosahexaenoic acid (DHA, C22:6). Linseed seed is also rich in soluble and insoluble fibers and lignans, makes it useful as a dietary supplement. Intake of flaxseed in daily diet may reduce the risk of cardiovascular diseases such as coronary heart disease and stroke. There is also evidence that flax has anticancer effects in breast, prostate and colon cancers. Flax fiber is used in the textile industry for linen cloth and also in paper industry. The residues remaining after the oil extraction from linseed contains about 35-40% protein and 3-4% oil, a rich source of feed to livestock like cattle and buffalo. Flax is naturally high in polyunsaturated fatty acids (PUFA), more specifically in ω-3 fatty acids; and hence flax seed as a component of poultry meal, can provide ω-3 enriched eggs. Rapid drying linseed oil is used for several purposes in industry, including paint and flooring (linoleum) industries. Because of its novel oil profile, flax may also be a suitable platform crop for synthesis of specialized industrial and nutraceutical products. Due to value addition in cultivars farmers will get more price. The time has come to formulate the research program based on the quality parameters as descried aforesaid. The centre has already been developed number of varieties having such quality as mentioned above. Blending of linseed oil with other edible oils ie., Palmolein, rice bran and coconut oil will give an appropriate plate farm to reduce its rancidity and self life beyond three months. Futher long term studies to be needed for confirmation of results. For achieving more, an intensified research program is needed to generate new materials having above mentioned qualities which are need of the day.

The area under crop will increase in the state definitely due to more profitable and most suitable crop under varying eco- edaphic condition. For the above purpose (area expansion) more number of front line demonstration under different component technologies viz, whole package, nutrition, varietal, plant protection and intercropping has to be undertaken.

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1. Potential technologies which need to be promoted

Package of practices along with attainable yield levels

Selection of field/land preparation: Loam soils, 2-3 ploughing with planking

Seed treatment : Thairum+Carbendazim @ 3.0 g/kg of seed

Sowing time : First fortnight of November

Seed rate/sowing method : 25 kg/ha, Line sowing with Row to row & Plant to plant distance

25 X 5 cm^2

Fertilizer doses : Irrigated condition

80:40:20:20: 5:: N:P:K:S:Zn kg/ha along with 5 t FYM /ha

: Rainfed condition

40:20:20:10: 5:: N:P:K:S:Zn kg/ha

Weed control : Metsulfuron methyl 4g ai /ha along with clodinaphop 60 g /ha is effective against broad and narrow leaf weed management as post emergence at 25-30 DAS.

Disease & Pest Control : Deep summer ploughing at the interval of 3-5 years, seed treatment with Thirum+Carbendazim @ 3 g /kg seed and biofertilizer viz, *Azatobactor* and *Pseudomonas* **@** 5 g /kg seed.

Table 1. Insect pest of linseed and systematic approach for their management

Time of practices/ growth stage	Target Pests	Control measures
Pre-sowing	Bud fly and other insect pests	Solarization of soil through summer ploughing, avoid continuous cultivation of linseed in same field.
Land preparation	Termite	Apply 2.5 q neem cake /ha or chloropyriphos 20 EC @ 1 litter/ha. in soil when termites are regular and heavily damaging pest.
Sowing	All major pests	Sowing may be restored 10-15 days earlier to minimize the bud fly infestation; selection of suitable resistant varieties Neela, Kiran, and moderately resistant high yielding varities like JLS 27, JLS 66, JLS 67, JLS 73, JLS 79 , JLS 95, Sharda, PKVNL 260, Kartika and Sharda etc.
Seedling stage	Cut worm and termite (moderate infestation)	Dusting of the crop with methyl parathion 2 % @ 25 kg/ha
Vegetative stage	Leaf minor, sap sucking pests and	Apply dimethioate 30 EC (0.03%) or spray imidacloprid 17.8 SL @ 50 ml/ha as and

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	defoliators	when required
Flowering stage	Bud fly, leaf minor, defoliators and sap sucking pests (6.0% ETL for bud fly and moderate to severe damage for other pests)	Use light trap for bud fly. Use of attractant (1 kg jaggery in 75 lit. of water and chloropyriphos @ 1 ml/lit) for bud fly, use of bamboo/wooden pegs as dead perches for predatory birds, spray forthnightly neem based formulations (0.5%) or spray imidacloprid 17.8 SL (0.04%) or spinosad 45 SC (0.015%) alone or with mancozeb (0.2%) for control of leaf minor , defoliaror and other sap sucking pests as per above given schedules.
Capsule formation stage	Gram pod borer (Moderate to heavy damage)	Apply HaNPV @ 250-300 LE/la

Table 2. Diseases of linseed and systematic approach for their management

Disease with causal organism	**Prevalence in the country/ specific area**	**Control measures**
Wilt (*Fusarium oxysporum*)	Incidence throughout the country but more prevalent in central part. Average loss 12-15 % if continues certification loss up to 70 %	Timely sowing, Soil solarization by ploughing; avoid continuous cultivation of linseed in the same field; 2-3 years rotation is most effective prevention ; use of the resistant varieties, effective technology for management of better germination and crop growth as well as linseed wilt by use of biofertilizers (*Azatobactor* and *Pseudomonas* 5 gm / kg seed) after seed treatment with mixed fungicide (carboxin + thiram) fungicide @ 2.5 g/kg seed and soil treatment before planking @ 2.5 kg/ha *Trichoderma virdae* .
Alternaria blight (*Alternaria lini and Alternaria linicoa*)	Prevalent in Northern region having humidity range of 90-95% and temperature 25-30 0C. average loss 20-35% if atmospheric conditions suitable loss up to 60%	Timely sowing, Use of the resistant varieties, seed treatment with mixed fungicide (carboxin + thiram) @ 2.5 g/kg seed. Spray of carbendazim +mancozeb @ 2.5 g/lit. water.
Rust (*Melampsora lini*)	Prevalent in Northern region of the country & serious in colder hilly regions.	Timely sowing, Use of resistant/tolerant varieties. Destroy plant debris and weeds to reduce the primary source of infection. Use of clean seed, seed treatment with

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		Carbendazim. Spray Propiconozole or hexaconazole (0.1%)) at 15 days interval to control the disease.
Powdery mildew (*Oidium lini*)	Throughout the country loss were depend on time of sowing, early sown (15 October) no loss, late sown (25 November) loss upto 20%	Timely sowing, Use of resistant/tolerant varieties, early sowing, 2-3 spray of Calixin (0.05%) or Sulphex (0.02) or Wettable sulphur (0.3%) reduce the disease.
Dodder/cascuta (*Cascuta hylina*) Plant parasite	Chhattisgarh, Madhya Pradesh and Vidarbh region of Maharasthra, Losses upto 5-8 %	Mechanical removing of parasitic vine from fields and parasitic seeds lot; Preventing the movement of grazing animals from infested fields, Restricting the flow of irrigation water from infested area. Spray 2-4 D @ 0.5 kg/ha.