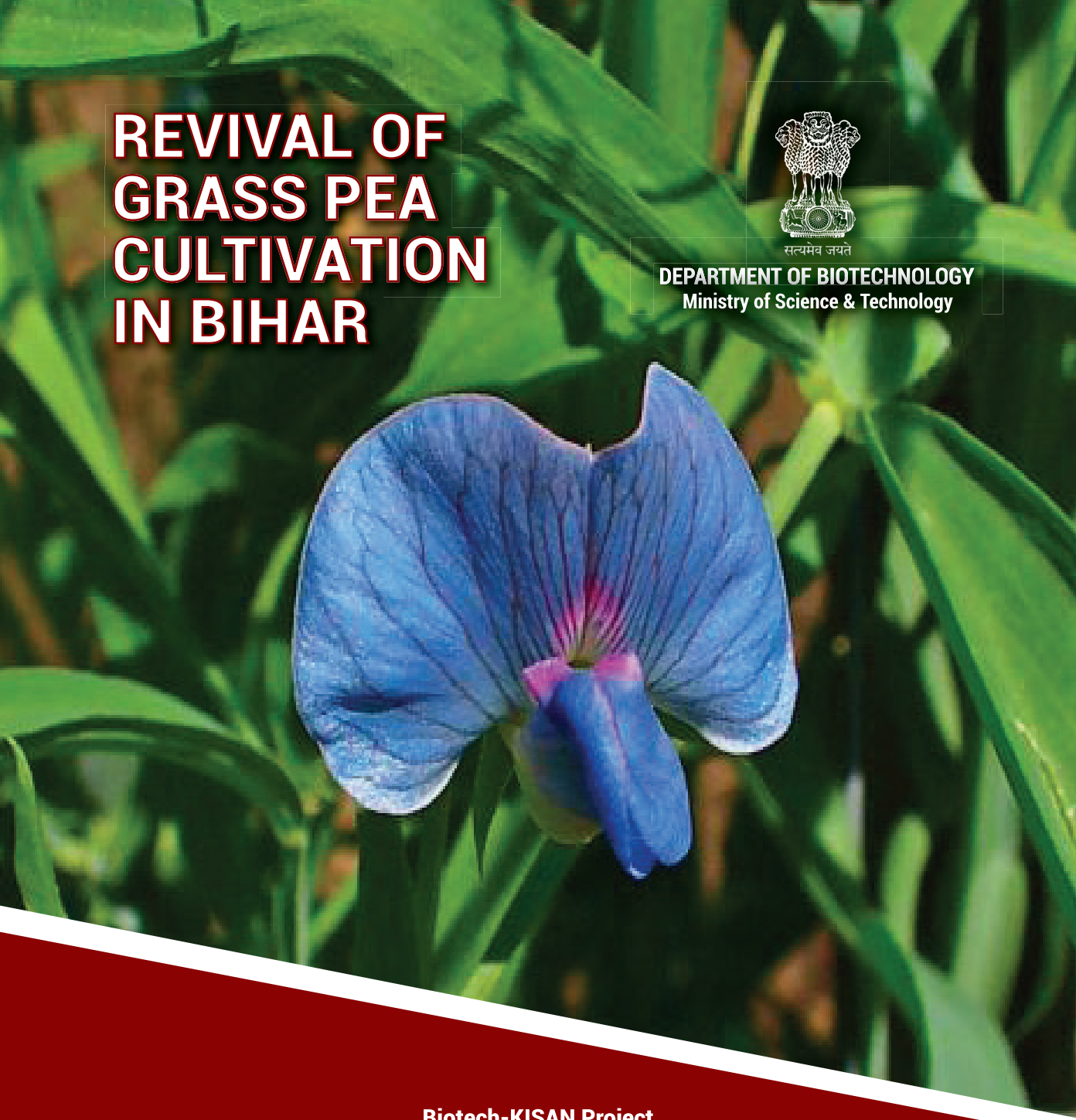
REVIVAL OF GRASS PEA CULTIVATION IN BIHAR



सत्यमेव जयते

DEPARTMENT OF BIOTECHNOLOGY
Ministry of Science & Technology

Biotech-KISAN Project
Directorate of Extension Education
Bihar Agricultural University, Sabour
&
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Government of India

Cover Page: Front and Back -Grass pea at Flowering Stage

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Bihar Agricultural University, Sabour

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Message

Quite a large extent of rice fallow agricultural land remains barren during Rabi season. Proper utilization of rice fallow land, through a cropping system that is beneficial for farmers and also useful in replenishing the soil nutrients, is quite challenging. In past lathyrus also referred as grass pea used to be cultivated in rice fallow land in majority of areas of state by farmers to ensure they could have a crop by the time they take up cultivation of major crops in ensuing agricultural season. Due to low input cost of cultivating grass pea, used as both food and fodder, farmers used to register high income growing grass pea. However, taking note of the fact high ODAP content in local varieties of grass pea was harmful for human. In fact, a ban was imposed in past by government on cultivation and storage of grass pea. In fact, utilization of rice fallow land posed a major challenge, particularly after cultivation of grass pea was banned primarly, to prevent consumption. Bihar used to be among leading states of country in pas that used to produce in huge quantity Khesari Dal prepared from grass pea. While things were proving difficult in utilization of rice fallow agricultural land, development of two new researched varieties Ratan and Prateek having low ODAP content was a welcome relief. Subsequently lifting of ban by government imposed on lathyrus cultivation paved way for restoring cultivation of grass pea in state.

I am pleased to know Bihar Agricultural University has been entrusted responsibility of promoting cultivation of new grass pea varieties in state under Biotech-KISAN Hub Project funded by Department of Biotechnology under union Ministry of Science and Technology. I am hopefully the problem of proper utilization of rice fallow land would be mitigated to great extent with promotion of the new varieties by university. The value addition of lathyrus or grass pea to my opinion can make it a highly remunerative crop, I am thankful to Dr R K Sohane, Vice-Chancellor, Bihar Agricultural University, Sabour & his team of Scientists for his efforts to ensure successful implementation of Biotech-KISAN Hub Project aiming at popularizing cultivation of new grass pea varieties. As team leader his efforts to make farmers aware that value addition of grass pea could better supplement their income is also praiseworthy. I hope with efforts of university in future more grass pea growers would take to value addition of their produce particularly Khesari Dal, a byproduct of grass pea.

(Amarendra Pratap Singh)

सत्यमेव जयते

डॉ. रेणु स्वरूप
DR. RENU SWARUP

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MESSAGE

The Department of Biotechnology through its National Biotechnology Development Strategy announced in 2015 lays major emphasis on generation of biotech products, processes and technologies for enhanced efficiency, productivity and cost-effectiveness in the areas of agriculture, food and nutritional security, affordable healthcare and wellness, environmental safety, clean energy, bio-fuel, bio-manufacturing, etc.

India is world largest consumer and importer of pulse. It becomes imperative to bring self-sufficient in the pulse production and ensuring nutritional security of common mass towards "Atmanirbhar Bharat". Grass pea was once significantly economic pulse crop in India,especially Eastern India. However, due to higher neurotoxin(ODAP), its cultivation was restricted. After the scientific research few low neurotoxin levelvarieties have been developed, which need demonstration infarmers' fields. Ratan (Bio L 212) and Prateek (LS 157-14) possessing <0.1% ODAP content is such two varieties. In the year 2016, Government of India lifted the ban on cultivation of grass pea and also encouraged for its wide cultivation. The Department of Biotechnology, Ministry of Science & Technology, Government of India felt its importance in the national economy and nutritional security, and supported the activity for popularizing grass pea cultivation of low ODAP varieties (Ratan & Prateek) in Bihar under Biotech-KISAN Hub at Bihar Agricultural University, Sabour.

I am happy to learn that the University has made a lot of effort to popularize grass pea cultivation in Bihar by judicious use of Rice fallow areas. Last year the University produced 1,050 q seed from 210 acres farmers' field through Participatory SeedProduction. There is huge scope for increasing the area under low ODAP grass pea cultivation in Bihar, considering the existing local grass pea growing areas and rice fallow areas during *rabi* season. This also enhanced net income of farmers to extent of ₹11,000 - ₹17,000 per acre. The University is also promoting the value-added products viz. *Gahana Bari* & *Phul Bari*, extruded product (*Kurkure*), made from grass pea dal, and this paves the way for women empowerment by increasing their income.

My best wishes to Vice Chancellor, Bihar Agricultural University, Sabour and his team for successfully implementing the project. We hope the University will bring more areas under grass pea cultivation in Bihar and promote value added products derived from Grass pea dal.

(Renu Swarup)

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Foreword

Grass pea (*Lathyrus Sativus* L.), once an economically significant crop in India, used to be cultivated extensively in Bihar; however, with passage of time the crop had lost its popularity primarily because of its long term consumption exhibited an adverse effect on human health due presence of high ODAP content in the local cultivars. Taking note of the problem, cultivation of the crop was subsequently banned by the government. However, the ban was lifted in 2016 following release of low ODAP containing *lathyrus* varieties viz. Ratan (Bio L 212) and Prateek (LS 157-14) possessing < 0.1% ODAP content in their seeds.

Promotion of cultivation of both the new varieties of grass pea was initiated under the project 'Biotech-KISAN of the Department of Biotechnology, Government of India during 2018. Under the project, Bihar Agricultural University, Sabour was entrusted responsibility of popularizing the new grass pea varieties in the state of Bihar by promoting their cultivation. Patna, Aurangabad, Nalanda, Bhojpur, Jehanabad, Lakhisarai had been among major grass pea producing districts of state in past; however, due to adverse effects of consumption of local grass pea cultivars on human health, the aforesaid districts also witnessed sharp decline in its cultivation. Almost a forgotten crop, cultivation of grass pea, however, has again picked up in state since efforts for promoting cultivation of Ratan and Prateek, the new grass pea varieties, were initiated. Revival of grass pea cultivation in state is significant taking into account that the crop is used for different purposes like source of protein as well as fodder for the livestock. The protein-rich grass pea also fits well in the rice fallow land which are abundant in the state and are not generally utilized.

I would like to place on record the sincere and dedicated efforts of the Sr. Scientists and Subject Matter Specialists of the *Krishi Vigyan Kendras* of Patna, Gaya and Lakhisarai for their dedicated efforts in popularizing this important pulse crop, which has succeeded in drawing attention of farmers besides the field staff of the department of agriculture, Government of Bihar.

I would like to place on record the financial support from the Department of Biotechnology, Ministry of Science and Technology, Govt. of India in sanctioning the project. I am also thankful to Dr AK Singh, Former Vice Chancellor, BAU Sabour for his keen interest and support to this project.

02/2/21

Dated Jan. 30, 2021

(RK Sohane)
Vice Chancellor

Contents

Acronyms & Abbreviations

BAU	Bihar Agricultural University
Biotech	Biotechnology
BOAA	β-N-oxalyl-amino-L-alanine
DBT	Department of Biotechnology
DEE	Directorate of Extension Education
FIG	Farmers Interest Group
FY	Financial Year
KISAN	Krishi Innovation Science Application Network
KVK	KrishiVigyan Kendra
ODAP	β-oxalyl-L-α,β-diaminopropionic acid
Prateek	LS 157-14
PSMC	Project Steering and Monitoring Committee
q	Quintal
Ratan	Bio L212
S&T	Science and Technology
SHG	Self Help Group
TL Seed	Truthfully Labelled Seed
VC	Vice Chancellor
WSHG	Women Self Help Group

Acknowledgements

We express our sincere gratitude to all farmers of Gaya, Lakhisari and Patna districts of Bihar state who actively participated in Biotech-KISAN (Krishi Innovation Science Application Network) Project dealing with mainstreaming the cultivation of low ODAP containing varieties of grass pea. By associating themselves with the project the farmers had significantly contributed in success of the project. It was their willingness to revive cultivation of grass pea (*Lathyrus sativus*), almost a forgotten crop in state which paved the way for successful implementation of the project. The feedback of farmers had been crucial in assessing impact of this project on their income and reduction in protein malnutrition.

We acknowledge generous funding support received from the Department of Biotechnology, Ministry of Science & Technology, Government of India for Biotech-KISAN Hub Project. We acknowledge the encouragement and support receive from Dr Renu Swarup, Secretary, Department of Biotechnology, Ministry of Science & Technology, Government of India for successfully implementing this project. We are also grateful to Dr. Mohd. Aslam Adviser (Scientist 'G'), Department of Biotechnology, Ministry of Science & Technology, Govt. of India for his meticulous guidance to execute this farmer friendly project. We are also thankful to Dr H S Gupta, Chair of the Project Steering and Monitoring Committee for critically going through the mansuscript.

We acknowledge the guidance received from Dr R K Sohane, Vice Chancellor Bihar Agricultural University, Sabour for successful implementation of the project. The authors express their deep sense of gratitude for all out support extended by Dr AK Singh, the then Vice Chancellor, Bihar Agricultural University, Sabour in implementation of the project. His guidance helped immensely in attaining objectives of the project. Vice Chancellor was kind enough to spare time for monitoring progress of the project on regular basis. Dr R N Singh, ADEE BAU, Sabour immensely contribute in execution of the project and we are thankful to him.

We are also grateful to Dr Mrinal Vema, Dr Mahendra Singh, Dr Seema, Dr Tirthartha Chattopadhyay, Dr BD Singh, Dr Ashok Kumar, Mr Ishwar Chandra, Project Fellow and Staff for their active support for implementing this project.

Chandan Kumar Panda
Uday Prakash Narayan
Rajeev Kumar
Devendra Mandal
Md Wasim Siddiqui

Executive Summery

Grass pea (*Lathyrus sativus* L.), once an economically significant crop in India, used to be grown widely in Bihar, West Bengal, Odisha, Chhattisgarh and Madhya Pradesh. However, with passage of time, grass pea cultivation was discontinued largely due to presence of high quantity of neurotoxin, ODAP (β-oxalyl-L-α,β-diaminopropionic acid), which, if ingested in significant quantity, caused lathyrism. Advancements in grass pea breeding led to development of new varieties of grass pea containing low (<0.1%) quantity of ODAP. The new varieties safe for human consumption it was established do not lead to lathyrism in human being. The Bihar Agriculture University (BAU) through its Directorate of Extension Education along with Department of Biotechnology, Ministry of Science and Technology, Government of India, jointly initiated a programme for popularizing cultivation of new varieties of grass pea in the state through Biotech-KISAN (Biotech-Krishi Innovation Science Application Network) Project. A sum of Rs 88.39 lakh was allocated for the project to meet two-year implementation cost of project. The demonstration of Ratan and Prateek varieties of this legume crop possessing less than 0.1% ODAP, the permissible limit; is the major objective of this project. Grass pea is a climate resilient crop grown mostly in rice fallows. The productivity of the new varieties was significantly higher than the traditional varieties of grass pea cultivated by the farmers. The cultivation of the new varieties following scientific method has helped in enhancing net income of farmers to extent of ₹11,000 - ₹17,000 per acre (₹27,500 - ₹44,000 per ha) in the areas where the project was implemented. The net income, of course, depended on the sale price of the produce, which was ₹3,700/q during 2019 and ₹4,200/q during 2020 as per price fixation committee of the BAU, Sabour. However, when the farmers sell the produce in open market, they would receive rate of at least₹₹3,500/q. Taking an average yield of 10-11 q/ha, the gross income is expected to be ₹35,000-₹38,500/ha. After deducting ₹8,000/ha as cost of cultivation, a net profit of ₹30,000/ha is assured. In addition, domestic use of grass pea as pulse will help in reducing protein malnutrition among the farmers and grass pea straw is used as fodder for cattle.

In order to popularise the recommended varieties of grass pea *viz.* Ratan and Prateek, a robust seed chain was required to be in place but a number of local grass pea varieties (with ODAP content above permissible level) were being cultivated in approximately 50,000 ha area in Bihar. This presented a big challenge in developing proper seed

chain for the two recommended varieties *viz.* Ratan and Prateek. To overcome this formidable challenge; several Farmers Interest Groups were formed for participatory seed production and the farmers were educated about higher level of ODAP content in local varieties and its implication on large scale consumption. They were also made aware about field performance of low ODAP-containing varieties, which yields higher than the local varieties of grass pea. This awareness program had salutary effect and a number of farmers' group evinced interest in cultivation of new grass pea varieties with low OPAP content.

Resultantly, during the last *Rabi* season (2019-2020), a total of 1,050 (one thousand and fifty) quintals of grass pea seed was produced through the Farmers Interest Groups in 210 acres area in farmers' field. These Farmers Interest Groups are working through the Krishi Vigyan Kendra in Gaya, Lakhisarai and Patna. The support of the Krishi Vigyan Kendras by providing quality seed (30 kg/acre), bio-fertilizers, technical advice on scientific cultivation of grass pea besides regular monitoring was critical for the success. Having popularised cultivation of grass pea, efforts were made to enhance net income of the grass pea farmers by ensuring value addition to the produce. Innovative ways for value addition of grass pea are dal and flour. Out of this, flour was used for preparation of *Gahana Bari* & *Phul Bari*, extruded product (*Kurkure*). The marketing of these products proved beneficial and helped in increasing income of the farmers. Attempts are now being made to link this value addition through women Self Help Groups. This opens yet another avenue for farm women for their financial independence and empowerment.

It is now expected that the state department of agriculture will organise systematic dissemination of this technology in other parts of Bihar especially Aurangand, Navada, Jahanabad, Bhojpur, Rohtash, Nalanda and East Champaran districts, which have sizable area under grass pea.

1 Introduction

Grass pea (*Lathyrus sativus L.*) once an economically important crop in India used to be grown widely in Bihar, West Bengal, Odisha, Chhattisgarh and Madhya Pradesh. It's a drought-tolerant legume containing 31% protein, 41% carbohydrate and 17% dietary fibre[1]. The crop is capable of adding adequate nitrogen and organic matter in soil upon incorporation[2]. The cultivation of grass pea was, however, banned in India on account of spread of lathyrism[3], which causes paralysis and muscle atrophy of lower limbs due to consumption of a diet consisting of about 25% *lathyrus* for a period of 2-6 months as grass pea contained high concentration (>0.1%) of toxin called ODAP(β-oxalyl-L-α,β-diaminopropionic acid).The samples collected from erstwhile Madhya Pradesh and Bihar states have been reported to contain 0.1-0.25% ODAP[4]. However, during last 40 years, a number of varieties of grass pea have been developed[1,2] which contain less than 0.1% ODAP and are safe for human consumption.This paved the way for commercial cultivation of this legume,[5,6]. The cultivation of grass pea has been receiving attention in the country following change in policy concerning its cultivation at the level of Government of India. In light of this policy change, the earlier ban on cultivation of this crop has been repealed [5,6]. Coupled with this; availability of low ODAP (<0.1%) containing varieties, its hardy nature with climate resilience and reasonably good yield in Tal areas, an attempt was made by the scientists of BAU, Sabour in association with scientists of the Krishi Vigyan Kendras (KVKs) to demonstrate and popularise cultivation of grass pea in few districts of Bihar. In view of reasonable productivity coupled with low input cost, the farmers were attracted and showed tremendous enthusiasm in adopting cultivation of grass pea in various districts of Bihar specially Gaya, Lakhisarai and Patna.

Ratan[1] (Bio L212 developed by the IARI in 1997) and Prateek[1] (LS 157-14 developed by IGKVV, Raipur in 2006) the two new grass pea varieties with low ODAP content (<0.1%) and considered safe for human consumption[3,4] were promoted for cultivation by Directorate of Extension Education, BAU, Sabour from the year 2018 under Biotech KISAN Project of Department of Biotechnology (DBT), Ministry of Science and Technology, Govt. of India. A sum of Rs 88.39 lakh was provided for two years under the Project for promoting cultivation of low ODAP containing varieties. Due to high neurotoxin (ODAP) content, cultivation of local grass pea varieties was discouraged in the state for quite a long time. As per information, since 2016, there has been shift

in policy of central government with regards to *lathyrus* cultivation [3,4]. And taking into account the prevalence of shortage of pulses in India; cultivation of grass pea varieties with low ODAP content is being encouraged by the government following policy shift. The project was launched in Gaya, Lakhisarai and Patna districts through the Krishi Vigyan Kendras of the university during the year 2018.

Figure 1: Grass pea in Vegetative stage

Figure 2: Grass Pea in Flowering Stage

Figure 3 : Grass pea in pod formation stage

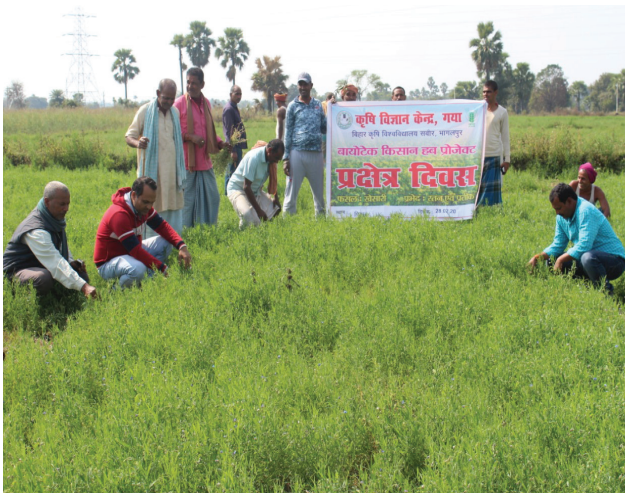


Figure 4: Field Day Organized for popularizing Grass pea cultivation

2 | Status of Grass Pea Cultivation in Bihar

During *rabi* season, the major pulses grown in the state of Bihar are lentil, field pea, grass pea and gram. As per data available from the Directorate of Economics & Statistics, Govt. of Bihar while area under grass pea cultivation is on an average 50,452 ha; it is 1,47,914 ha in case of lentil, 56,477 ha in case of gram (chick pea) and 16,545 ha in case of field pea. Thus, area-wise, grass pea stands at 3rd position and it occupies area almost equal to that of chick pea. Taking into account the area under cultivation under grass pea in various districts of Bihar, the majorgrass pea growing districts are Patna (11,323 ha), Aurangabad (9,830 ha), Jahanabad (5,509 ha), Nalanda (4,215 ha) and Lakhisarai (2,022 ha).

2.1 Area under Grass Pea

Due to widespread cultivation of traditional varieties of grass pea, it had been a formidable challenge to establish a seed system of low ODAP varieties through production of quality seeds of these two low ODAP varieties viz. Ratan and Prateek. A beginning was made in *rabi* season of year 2018-19 when 46 demonstrations were planned and conducted in 33-acre area in farmers' field located in Gaya, Lakhisarai and Patna districts. Subsequently, larger number of demonstrations were conducted in extended area during 2019-20. Altogether, 215 demonstrations were held in 210 acres of land. This resulted in significant increase in seed production with a year. The total seed production went up to 1,050 q in 2019-20 as compared to 160 q during 2018-19.

2.2 Production of Grass Pea in Bihar

The statistics shows 51,379 tons of grass pea production with an average yield of 1,018 kg/ha. However, most of the grass pea cultivars are local containing higher ODAP content of >0.1% (above the permissible level). Table 1 shows the status of grass pea cultivation in the state.

Table 1: Area, Production & Yield of Grass pea during year 2018-19

Sl.No.	Name of the Districts	Grass Pea		
		Area (ha.)	Production (Metric Tons)	Yield (Kg/ ha)
1.	Patna	11,323	18,649	1,647
2.	Nalanda	4,215	4,771	1,132
3.	Bhojpur	2,625	2,885	1,099
4.	Buxer	624	907	1,454
5.	Rohtash	2834	2,681	946
6.	Bhabhua	624	425	681
7.	Gaya	189	142	751
8.	Jahanabad	5.509	6,457	1,172
9.	Arwal	892	671	752
10.	Nawada	817	641	785
11.	Aurangabad	9,830	5,053	514
12.	Saran	23	23	1,000
13.	Muzaffarpur	401	256	638
14.	E.Champaran	2,188	1,398	639
15.	W.Champaran	9	6	667
16.	Sitamarhi	102	65	637
17.	Sheohar	93	59	634
18.	Vaishali	24	15	625
19.	Darbhanga	221	196	887
20.	Madhubani	136	121	890
21.	Samastipur	412	366	888
22.	Begusarai	12	13	1,083
23.	Munger	98	103	1,051
24.	Shekhpura	700	825	1,179
25.	Lakhisarai	2,022	2,030	1,004
26.	Khagaria	179	188	1,050
27.	Bhagalpur	1,366	665	487
28.	Banka	112	55	491

29.	Saharsa	198	106	535
30.	Supaul	1,846	991	537
31.	Madhepura	355	191	538
32.	Kisangunj	393	353	898
33.	Katihar	80	72	900
Total		**50,452**	**51,379**	**1,018**

Source :- Directorate of Economics & Statistics, Govt. of Bihar, 2018-19

Grass pea pods

3 | ODAP Content in Grass Pea Cultivars

Qualitative analysis of seeds in terms of ODAP content procured by university from farmers corroborated low level of ODAP content, thereby establishing the fact that the new varieties viz.Ratan and Prateek were safe for human consumption. It has been reported that ODAP content in grass pea varies with the area.

The data on ODAP content in the samples collected from the seeds produced under farmers' field is collated and presented as follows:

Table.2. ODAP content in the Grass Pea Varieties cultivated in different Districts

Sl. No.	Name of the Place for Seed Production	Name of the varieties	% ODAP Content (average of 3 coded replications in blind samples)
1	Gaya	Ratan	0.048 to 0.061
		Prateek	0.061 to 0.063
		Local Variety	0.212 to 0.269
2	Patna	Ratan	0.042 to 0.053
		Prateek	0.045 to 0.048
		Local Variety	0.141 to 0.186
3	Lakhisarai	Ratan	0.043 to 0.057
		Prateek	0.047 to 0.051
		Local Variety	0.139 to 0.199

4 | Package of Practices

Package of practices have been worked out at the BAU, Sabour. The details of date of sowing time, land preparation, seed rate, method of sowing, intercultural operations, harvesting, threshing, packaging and storage are presented below:

4.1 Time of sowing

Grass pea is generally sown on residual soil moisture after harvest of *kharif* rice crop. Most suitable time for pure crop is latter half of October to early November. In case utera/paira cropping, sowing time depends on maturity of kharif crop. In general, sowing period of mid-October to last week of October is most suitable.

4.2 Soil type and Land Preparation

Grass pea can be grown in all type of soils except highly acidic soils. However, heavy soil of low lying areas is more suitable for grass pea cultivation. The crop is excellently cultivated in clay loamy soil. Under paira/utera condition, no tillage is required and the good quality seed is sown in rice field two weeks before harvesting of rice crop. However, for planting as new crop after harvest of rice, one deep ploughing followed by cross harrowing is recommended and after that planking is necessary to level the field and prevent loss of moisture

4.3 Seed treatment

The seed is recommended to be treated with Thirum 3g / kg before sowing. After seed treatment with fungicide, seed should be inoculated with Rhizobium and PSB culture @ 5 - 7 g/ kg of seed.

4.4 Seed rate

Under Utera/paira cropping seed rate is 70-80 kg/ha, however, in line sowing it ranges from 40 to 50 kg/ha. In line sowing, row to row and plant to plant spacing is maintained at 30 cm x 10 cm respectively.

4.5 Method of sowing

Under Utera/paira condition, seeds are broadcasted in standing rice crop. However, in pure/sole crop, broadcasting and line sowing is invariably followed.

4.6 Weed management

Under utera/paira cropping, there is no need of weed management as it suppresses the weeds in field.However, in line sowing one hand weeding at 30 - 35 days after sowing is required to keep the crop free from weeds. Weeds can also be managed effectively by spray of fluchloralin (Basalin) 45 EC @ 0.75 - 1 kg a.i./ha in 750 - 1000 liters of water as pre-plant incorporation.

4.7 Disease and Insect-Pest Management

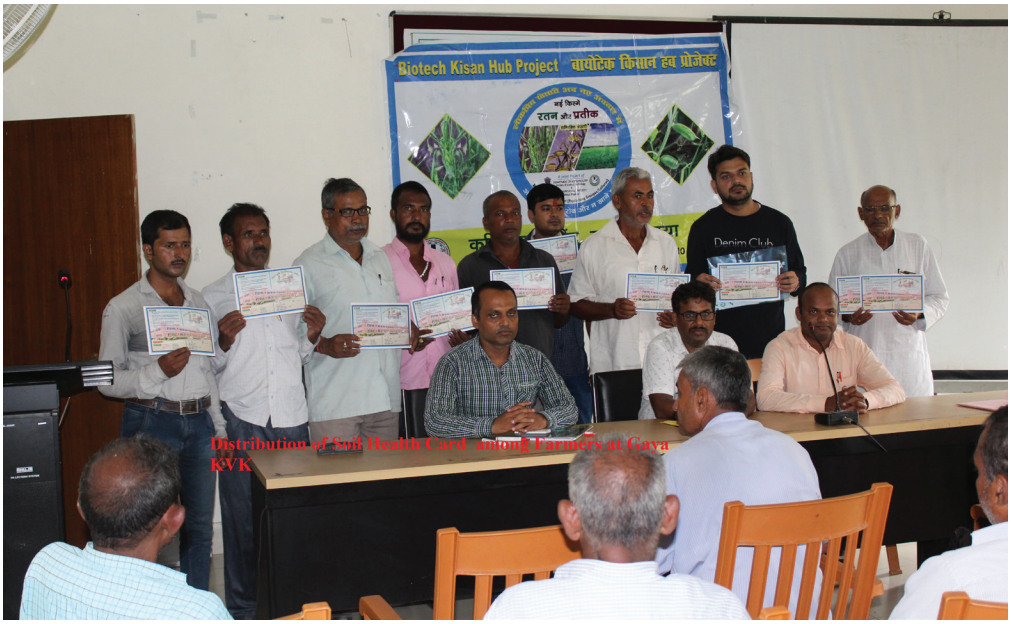
The pest infestation as well as manifestation of diseases being less compared to other crops is an advantage in case of grass pea. However, possibility of infestation of thrips (*Caliothrips indicus*), an insect-pest that sucks juice from leaves cannot be ruled out totally. As a result of infestation, the leaves turn brown and crumpled besides plant develop sickly look. Overall infestation of thrips could lead to adverse economic effect on crop prospect. Spray of Dimethoate 30 EC @ 1.7 ml/ liter or oxydemetonmethy (Metasystox) 25 EC @ 1 ml/liter of water or Imidachloprid (17.8 SL) @ 250 ml/ha is an effective remedial measure for preventing infestation.

4.8 Harvesting, Threshing and Storage

The crop matures and attains harvesting stage in the period between last month of March and first week of April. Harvesting of crop should be done when colour of the pods changes from green to brown and grains are at dough stage having approximately 15% moisture. Harvested produce may be allowed to dry in sunlight for a week. After 3-4 days of sun drying,the produce needs to be roped in bundles and shifted to threshing floors. Threshing is done by beating with sticks or trampling under the feet of bullocks. The clean seed needs to be sun dried for 3-4 days in order to reduce moisture content up to 9 - 10%. Now the produce should be safely stored in appropriate bins. A small quantity of the produce can also be protected by mixing inert material like (soft stone, lime, ash, etc.)

5 | Input Support to the Farmers

To support farmers, they were provided quality seed (30 kg/acre) and biofertilizers. The seed produced by farmers every year during the project period were processed, bagged, labelled, stored and supplied to the farmers in next cropping season. To ensure quality seed production, the farmers' field were regularly visited by project staff and scientists. This helped in strengthening activities of 'Farmers Interest Group' and also in maintaining purity of seed. The seeds, thus, produced were bought back by the BAU, under the Biotech-KISAN project and stored properly to maintain the quality standards



Distribution of Soil Health Card among the farmers

6 | Yield Performance in Farmers' Field

A large numbers of demonstrations were conducted in the farmers' field during the crop season of 2018-19 and 2019-20 in three districts of Bihar taking a local variety of grass pea as check against the two low ODAP containing varieties viz.Ratan and Prateek. Performance of the different cultivars in the three districts are collated in Table 3

Table 3. Performance of Low ODAP varieties and local check in the Demonstrations

Sl. No.	Districts	Name of the villages	Name of the varieties	Yield (q/ha)
1	Gaya	Mahandpur, Tekari, Konch, Chainpura, Sherghti, Milkhor, Atri, Khijarsari, Bela, Mohra	Ratan	11.43
			Prateek	11.06
			Local Variety	9.18
2	Lakhisarai	Ramgarh, Halsi, Chan Ramcharantola, Barhiya Noma	Ratan	12.49
			Prateek	11.95
			Local Variety	10.17
3	Patna	Lodhipur, Danapur Murtazapur, Belchhi Dabhawan, Pandark Chakjalal, Pandark Somia, Barh Badpur, Mokama Nahwan, Masauri Nimchak, Barh	Ratan	12.13
			Prateek	11.51
			Local Variety	10.46
	CV			8.914
	CD (5%)			1.753

7 | Capacity Building of Farmers

As cultivation of crop had been discontinued for years by many farmers; capacity building of farmers became necessary for reviving grass pea cultivation as well as for its crop management. Training programmes for farmers were conducted for the purpose at Krishi Vigyan Kendras and also in main campus of University at Sabour. Two training programmes were conducted each year by each of the KVKs on scientific cultivation of grass pea besides its management and value addition. The training programs helped in making farmers aware about scientific methods of grass pea cultivation and value addition apart from strengthening of the Farmers Interest Group.

Capacity Building of farmers through training

8 | Popularization of Grass Pea Cultivation

Having succeeded in creating awareness about importance of grass pea cultivation, efforts were made for expansion of area under grass pea. Several measures aimed at encouraging farmers for taking up cultivation of grass pea were taken up by BAU. Dramatized audio and video clips prepared by university are being circulated among farmers for the purpose. Several especially designed training programmes and field day programmes were also organized by university for popularizing the crop. As part of efforts, extension literature has been distributed among more than 2,000 farmers in course of various meetings, demonstration programmes and university Kisanmela.

The Information and Communication Technology(ICT) tools were also used for popularizing grass pea cultivation among farmers. A technical film developed on scientific cultivation of grass pea was made available to the farmers through social media like, YouTube, WhatsApp and Facebook. Since October 2019, the technical film has been viewed by total 9,715 viewers. For delivering information instantly to grass pea farmers and also for satisfying their queries a special WhatsApp group has been created. The technical film was also screened for farmers through Kisan Gyan Rath of university. To ensure viewing of the film by farmers using their mobile phones; the film was uploaded in SD cards and same was distributed among farmers. The SD card initiative was initiated taking into consideration internet facility is not up to the mark in many rural areas. The facility of receiving advisory through university Kisan Call Centre toll free number (Toll Free Phone No. 18003456455) and WhatsApp Group of the university named Crop Doctor (WhatsApp No. 7004528893) was also extended to farmers.

9 | Farmers Interest Group in Participatory Seed Production

As the number of recommended varieties of grass pea is limited, it became imperative to develop effective production chain of quality seed so that the same could be made available to farmers. For the purpose, FIGs were constituted in each district under the project. A buy-back policy was introduced by BAU while promoting cultivation of grass pea with twin objectives of increasing income of growers and also ensuring adequate availability. Under the buy-back policy, the university started purchasing produce of the growers from 2018 onwards after initiation of the project for promoting grass pea cultivation. The buy-back policy of university has proved lucrative for growers and has helped the university in building up adequate seed stock. At the end of the current harvesting season in month of March 2020, the BAU stock of seed was around 150 quintals. The seed was purchased at rate of Rs.4,200 per quintal from the farmers.

The FIG's consisting 100 to 115 members were formed in Gaya, Lakhisarai and Patna districts. Apart from seed production in participatory mode, the activities of FIGs include facilitating supply/distribution of inputs, popularizing *lathyrus* cultivation among fellow farmers, participation in Kishan Chaupal/gosthi, participation in training programme, organizing field day in collaboration with KVK's, value addition, motivating farmers to become members of FIG and making available quality seeds to KVK's which after processing so that the same could be supplied to growers prior to sowing season.

It was not a cake walk for university scientists and personnel to motivate farmers for formation of FIGs.In many cases, the farmers were hesitant about taking up cultivation of the crop on account of high neurotoxin content. The farmers in various FIGs were briefed about new varieties of grass pea that contain low level of neurotoxin, ODAP. Once convinced the new grass pea varieties Ratan and Prateek are safe for human consumption, the farmers agreed to take up cultivation of these varieties and also shared this information with fellow farmers.

10 | Value addition

After successfully promoting cultivation of grass pea varieties having low ODAP content in three districts viz. Patna, Lakhisarai and Gaya; efforts were stepped up to ensure grass pea growers are able to enhance their income through value addition of their produce. Consumed as Khesari Dal with rice and chapati like other pulses (lentil, mung, gram), grass pea is also used in preparation of besan. Adopting innovative ways of processing and value addition, farmers were able to prepare *Gahana Bari* & *Phul Bari* from grass pea flour which helped in increasing their income. Production of extruded product (*Kurkure*) from grass pea has been also taken up by farmers involving women Self Help Group.

10.1 *Gahana Bari* (Jewel *Bari*)

It is made in two combinations a) *Lathyrus* (50%) & Black gram (50%), b) and only *Lathyrus* (100%).

Ingredients : Husk-less *lathyrus* & black gram, huskless sesame seed/poppy seed and salt.

Tools : Mixture grinder machine, micro funnel and utensil as per requirement.

Methods of preparation : After soaking husk less black gram and *lathyrus* in water overnight, subsequently water needs to be drained out. Thereafter *lathyrus* and black gram is grinded separately using mixture grinder. The dust of *lathyrus* and black gram is mixed in equal proportion. *Gahana Bari* could be also prepared using only *lathyrus*

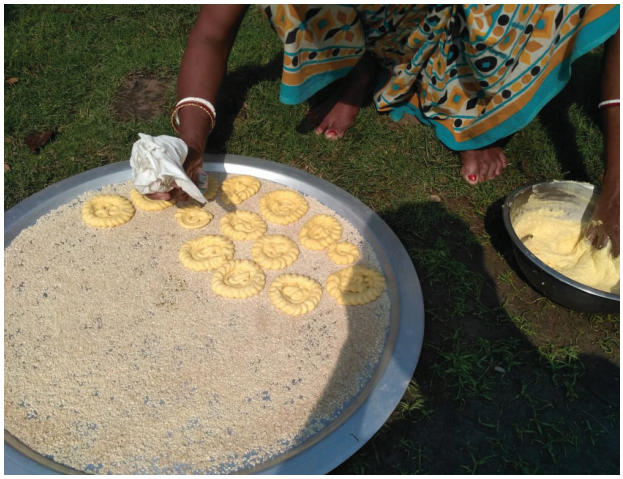


Figure 5 : Preparation of *Gahana* Bari

dust. However, in case of use of black gram with *lathyrus* for the preparation, salt needs to be added in mixture as per requirement. While preparing mixture it is essential moisture level remains maintained. Husk less sesame seed/poppy seed is used as basement material while drying the processed mixture. Use of sesame in base material makes *Gahana Bari* safe for consumption up to four months from time it is prepared. Use of poppy seed in base materials enables safe consumption of GahanaBori up to period of ten months from time period of preparation. The sunny days of winter season are ideal for preparing *Gahana Bari* (Fig. 5-8)

Figure 6 : Sun Drying of Gahana Bari

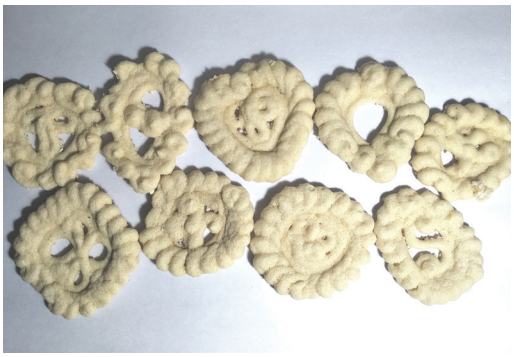


Figure 7 : *Gahana Bari* (Grass pea-50% & black gram- 50%) Ready to eat/cook

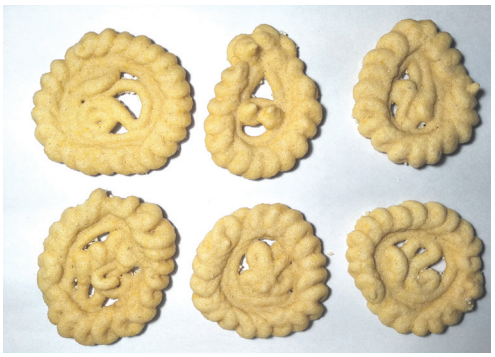


Figure 8 : *Gahana Bari* (Grass pea-100%) Ready to eat/cook

10.2 *Phul Bari* (Flower Bud *Bari*)

It looks like bud of flower and hence it is called *Phul Bari*. *Lathyrus is* used as main ingredient in preparation of *Phul Bari*.

Ingredients : Husk less *lathyrus* seed, Fennel seed (Nigella sativa) salt, ginger, dry chilli.

Tools : Mixture grinder machine, Micro funnel, Utensil as per requirement.

Method of preparation: Huskless *lathyrus* seed is soaked overnight in water. Followed by draining of water seed is grinded thoroughly with help of mixture grinder. Subsequently adding salt, fennel seed, ginger, and dry chilli in required proportion the ingredients are mixed properly maintaining proper moisture level. It is prepared during sunny days in winter season (Fig. 9-10).

Methods of preparation for consumption: Fried at low temperature in frying pan the preparation is ready for being served in two to three minutes' duration.

Methods of Consumption : It can be eaten as snacks with tea and also as starter besides could be consumed with rice and chapatti. Mixed in alubhorta (mashed potato) and vegetable curry it adds to taste.

Figure 9: Drying of *Phul Bari*

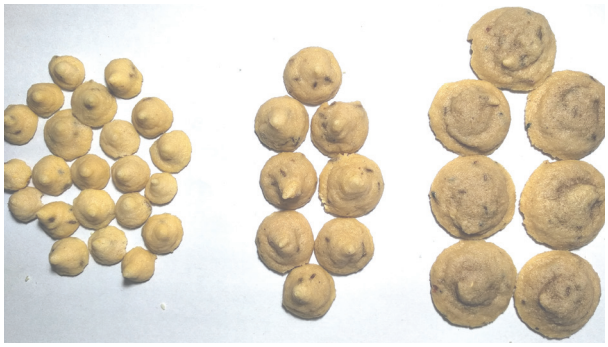


Figure10 : *Phul Bari* ready for Cooking

10.3 Extruded product (*Kurkure*)

Cereal-based extruded products such as *Kurkure* is highly popular snack consumed particularly during tea-break and travel time. The snack is popular among children too. The tasty extruded products also have better nutritional value. People allergic to gluten experience the problem in consuming wheat based *Kurkure* whereas no such problem is experienced on consumption of *Kurkure* prepared using *lathyrus* flour.

Ingredients : Corn flour (70%), Rice flour (10) and *lathyrus* flour (20%)

Additional ingredients : Salt (to taste), spices, chat masala, and flavour for seasoning.

Methods of preparation : Above mentioned ingredients along with salt need to be taken in a dough maker and 30 ml water needs to added per kilogram of flour. Maintaining proper moisture level, the ingredients needs to be mixed. Subsequently the finished product is transferred to seasoning bowl from processing unit. The *Kurkure* could be then seasoned as per flavour of choice (Fig. 11).

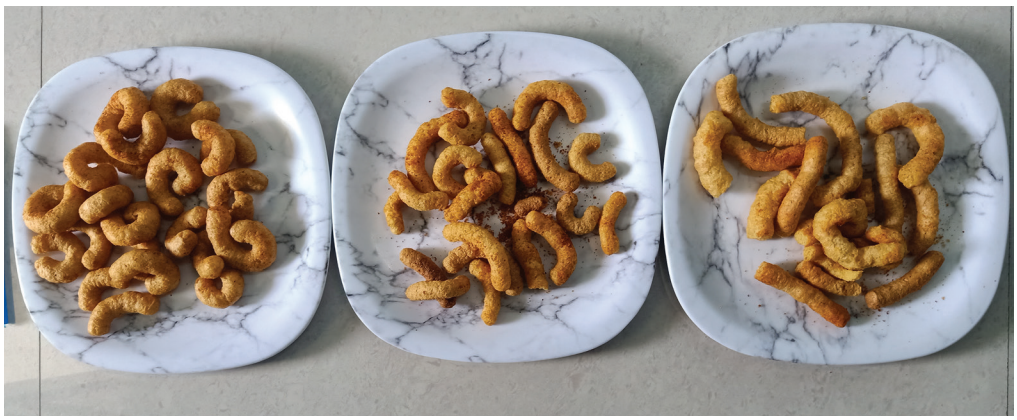


Figure 11: Ready to Serve *Kurkure*

10.4 Feed block with Straw of Grass Pea

The good health of animals depends on quality of feed provided to them. Feed blocks are complete innovation that can help our farmers in providing balanced diet to dairy animals and thereby increase their profit from milk production and dairy farming. The locally available feed ingredients could be also used in preparation of feed blocks. Feed blocks prepared using grass pea straw (*bhusa*) and other ingredients is quite palatable so far farm animals are concerned apart from the fact the feed blocks are capable of meeting nutritional requirement of animals (Fig. 13-18). The use of grass pea straw in feed block is one of the value additions in grass pea. The grass pea feed block is beneficial to the cattle and has fast become popular due to the following reasons:

- It ensures availability of cost-effective quality feed round the year
- It is cheaper in storage and transportation

- Provides added benefit of correcting a multi-nutritional deficiency in animals.

Ingredients Needed : The ingredients required are collated in Table 4.

Table 4. List of Ingrediens for Preparing Feed Block of Grass Pea

Dietary components	Amount (%)
Dry feed (Grass pea straw/*bhusa*)	50
Corn powder	20
Bran	15
Cuticle	12.5
Touched master	01
Mineral mixer	01
Salt	0.5
Total	**100**

Feeding method of feed block prepared from straw of grass pea

Cow/buffalo : 2 feed blocks morning & 2 feed blocks evening with normal animal feed; 5 feed blocks morning & 5 feed blocks evening when only feed block is given in animal feed.

Goat : 1 feed block morning 1 feed block evening only feed block; 1/2 feed block morning and 1/2 feed block in evening with normal feed.

Figure12. Straw of grass pea

Figure 13. Feed block machine

Figure14. Feed Block of grass pea

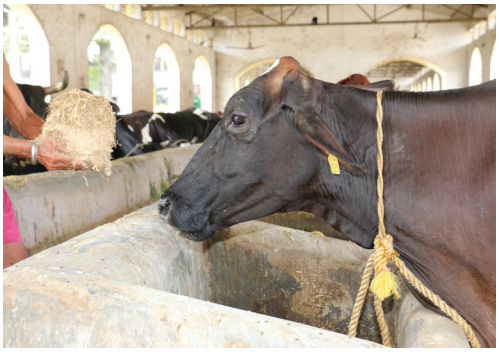


Figure 15. Feeding of Feed block prepared from straw of grass pea

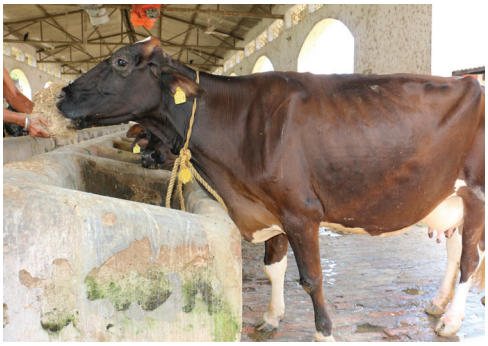


Figure 16. Feeding of Feed block prepared from straw of grass pea

11 | Financial benefits from Grass Pea Cultivation

Grass pea is cultivated during *rabi* season in Bihar. Lentil, gram & field pea are few other pulses grown during this period of the year. It is thus; appropriate to work out economics of grass pea cultivation *vis-à-vis* other pulses grown in same season so that farmers can take an informed decision about adoption of grass pea. The grass pea is mostly grown as paira/utera crop with rice crop. While grown under rice fallow, the resource utilization by this crop is minimum which brings down its cost of cultivation. Being climate resilient hardy crop, insect attack and pest infestation is also minimum in grass pea. The crop is less prone to diseases too. Fertilizer requirements are also minimum in case of grass pea. The demonstrated varieties gave good yield of 14-16 quintal per hectare. On an average farmer can earn net profit of Rs.27,500 per ha by grass pea cultivation. Following is the B:C ratio of different pulses grown in *rabi* season.

Crop	Lentil	Gram	Grass Pea
B:C Ratio	1.94	2.27	3.36

Harvested Grass pea in farmer's farmyard

12 | Success Stories of Grass Pea Growers

12.1. Mr. Sanjit Kumar Kushwaha

Village : Manjhla Bigha, Pandark,

District : Patna

Total Area : 2 acres (Year 2020)

Type of Land : Rice fallow

Current Use in *Rabi* : Fallow with zero return

Yield obtained : 12,18 q/ha

Gross Income : Rs. 43,830 from 2 acre

Expenses : Rs.7,200/- for 2 acres

Net Income : Rs. 36,630/- from 02 acres=(Rs 45,780/ha)

Shri Sanjit Kumar Kushwaha with grass pea

It was altogether a new experience for Shri Sanjit Kumar Kushwaha, a small farmer of Manjhla Bigha village in Pandark block of Patna district when he decided to start grass pea cultivation a little more than two years back. Almost a forgotten crop, cultivation of *Lathyrus* or grass pea commonly referred as Khesari has picked up substantially in the state since crop is being promoted by Bihar Agriculture University (BAU), Sabour under Biotech KISAN project, funded by Department of Biotechnology, Ministry of Science & Technology, Govt. of India.Cultivation of two new varieties of grass pea viz. Ratan and Prateek has been promoted by BAU for the last two years. Encouraged by BAU scientists, it was first time in 2018 Kushwaha decided to take up cultivation of climate resilient remunerative crop with support from Krishi Vigyan Kendra, Patna. Initially hesitant about starting cultivation of a crop that was discouraged in past; it was institutional support and encouragement of scientists that helped immensely in motivating him for *lathyrus* cultivation in his one acre of agricultural land. Khesari or grass pea, however, was not a new crop for ancestors of Kushwaha. More than a

decade back ancestors of Kushwaha used to cultivate grass pea. They discontinued cultivation of this crop after it became matter of common knowledge that *lathyrus* is not safe for human consumption. It was not only family of Kushwaha in his village who discontinued cultivation of grass pea but the majority of farmers in and around the village stopped cultivation of grass pea due to same reason. However, reintroduction of crop that his ancestors had once discarded proved beneficial for Kushwaha.

By taking to cultivation of Ratan and Prateek the new varieties of grass pea, Kushwaha increased his income and also ensured better utilization of his rice fallow land. After a small beginning in 2018, in subsequent years, he cultivated new varieties of grass pea in two acres land. Kushwaha told that in forthcoming sowing season, he intends to increase his area under grass pea cultivation. Kushwaha is not a solitary example who has increased his income and ensured better utility of his rice fallow land by cultivation of grass pea. Alike him many others have taken to cultivation of forgotten crop during the last two years. Corroborating farmers in increased number are taking to *lathyrus* cultivation, Kushwaha confessed that grass pea straw has fodder value and could fetch additional income for the growers provided better facilities are available for marketing. He is an active member of Farmer Interest Group formed for increasing area under *lathyrus* cultivation and also for creation of robust seed chain that could ensure supply of quality seeds to farmers involved in cultivation of grass pea.

12.2 Mr. Chunchun Kumar

Village : Ramnagar Bartara, Ramgarh Chowk

District : Lakhisarai

Type of Land : Rice fallow

Current Use in *Rabi* : Fallow with zero return

Yield obtained :12.5 q/ha

Gross Income : Rs. 63,000 from 3 acre

Expenses : Rs.9,000/- for 3 acres

Net Income : Rs. 54,000/- for three acres = (Rs. 44,460/ha)

Unlike many other farmers who, in the past, totally stopped farming of *lathyrus*

commonly referred as grass pea, Chunchun Kumar a progressive farmer and had never totally discontinued *lathyrus* farming. Well aware of the fact that excessive consumption of local grass pea variety is not safe for human consumption, Kumar, however had limited *lathyrus* cultivation to a great extent. In fact, for purpose of utilizing rice fallow land and also for animal feed; he kept growing local variety of grass pea though he was not much interested in cultivation of *lathyrus*. Kumar, who has 30 acres (12 ha) agricultural land, took up cultivation of crops that used to be grown by his ancestors. The main crops those he started growing included paddy and wheat. Alike his ancestors, Kumar also started growing grass pea in rice fallow, in order to ensure proper utilization of fallow land. At one point of time, he however started contemplating seriously on total discontinuation of grass pea cultivation. It was almost at this time in 2018 he was informed by scientists of Krishi Vigyan Kendra, Halsi and also by university scientists involved in implementation of Biotech-KISAN Project that two new grass pea varieties namely Ratan and Prateek have been specially developed to ensure grass pea is totally safe for human consumption. The Biotech-KISAN Project being implemented in state since 2018 was aimed at promoting cultivation of new grass pea varieties (Ratan & Prateek) with low neurotoxin content. Kumar was told by scientists that low ODAP content of Ratan and Prateek make the new varieties safe for human consumption. The scientists told him that instead of discontinuing *lathyrus* farming he should try the new varieties. Motivated by scientists Kumar started cultivation of Prateek one of the new varieties in 2018. Associated with KVK for quite a long time, as part of handholding, he was provided 25 kg seed of Prateek from KVK for starting cultivation of the new variety. Kumar took up cultivation of the new variety in two bighas of land. In first year, he recorded six quintal yield. With KVK had extended an offer to purchase his produce Kumar sold the entire yield to KVK at rate of Rs 3700 per quintal. His net income from farming of new *lathyrus* variety was quite encouraging taking into account the input cost of farming was restricted to approximately Rs 3,000/acre. In fact, income of Kumar from farming of new variety was more compared to farming of local variety. The year he started growing new *lathyrus* variety he had also cultivated local variety in small area. While Kumar sold his produce from new variety at Rs 3,700 per quintal, the sale of local variety yield fetched him Rs 3,100 per quintal. Encouraged from higher income from new varieties, he discontinued farming of local grass pea variety 2018 onwards.

Kumar had cultivated Prateek again in three acres of land during 2019 and recorded yield of 15 quintal from 3 acre of land. The buy-back offer had been extended once

again he sold his produce to KVK. The selling of produce in second year fetched Kumar further high return as his yield was purchased by KVK at rate of Rs 4,200 per quintal. The input cost of farming had hardly registered any increase compared to previous year; his net income was more in second year. In village of Kumar, nearly half a dozen farmers cultivated Prateek during 2020. The cultivation of new variety has also picked up in Bartara village located close to village of Kumar. The number of farmers taking to cultivation of new grass pea varieties have increased considerably in the area since new varieties are being promoted for cultivation under Biotech- KISAN Hub Project.

12.3 Mr. Binod Kumar Singh

Village : Nawada, Sherghati

District : Gaya

Type of Land : Rice fallow

Current Use in *Rabi* : Fallow with zero return

Yield obtained : 4.5 q/acre

Gross Income : Rs. 18,450 from one acre

Expenses : Rs.2,800/acre

Net Income : Rs. 15,650/- from one acres = (Rs 38,655/ha)

A progressive farmer of Gaya district, Mr Binod Kumar Singh was not comfortable with idea of *lathyrus* farming (due to its adverse effect on human health) when a proposal for the same was put forward by KVK scientists. Mr Singh, who has 14 acre of agricultural land holding, mainly grows paddy and wheat apart from pulses and oilseeds. He was approached by the scientists associated with Biotech KISAN Hub Project under which, cultivation of Ratan and Prateek - two new grass pea varieties having low ODAP content, was being promoted by Bihar Agricultural University (BAU). Family members of Singh used to cultivate local varieties of grass pea in the past; however, with passage of time they discontinued the same and it was in the year 1978 that grass pea was grown in 50 bighas of land by one of his cousins. Explained by scientists that new grass pea varieties are totally safe for human consumption, Singh agreed to start *lathyrus* farming on trial basis. He was provided seed of *lathyrus* from

KVK and Mr Singh cultivated Ratan variety of *lathyrus* in approximately one acre of land in the year 2018. He harvested 4.5 quintal/acre, which he sold at rate of Rs 4,100 per quintal. With input cost of cultivation remaining restricted between Rs 2,500 - Rs 3,000/acre, Singh registered attractive net income selling his produce. Contrary to his apprehension, he hardly had any problem in selling his produce. Singh had to simply convince the food grain dealers that his produce was totally safe for human consumption. Well acquainted with the dealers, he informed them the new varieties have been developed to ensure *lathyrus* is safe for human consumption. The first year experience of grass pea cultivation proved highly encouraging and he decided to cultivate grass pea again next year.

In 2019, he cultivated *lathyrus* almost in same oneacre area. Provided seed by the KVK, he cultivated Ratan variety of *lathyrus* once again. Though he harvested 4.5 quintals again; however, his net income from grass pea cultivation was not that encouraging compared to first year. Attempt of Singh to prepare and sell seed of *lathyrus* had not worked as per plan and this resulted in comparatively low income in the second year. With market rate of grass pea fluctuating between Rs 2,500 - Rs 3,000/q, his net income was slightly less compared to first year. However so far, Mr Singh is concerned, he was satisfied with his income. He decided to further increase area under *lathyrus* cultivation in succeeding year. During the year 2020, Singh cultivated Prateek variety in two-acre land. The crop is yet to mature; Singh is looking forward to a good harvest this year. Influenced by Singh, more than 20 farmers in village have started *lathyrus* farming. Total area under *lathyrus* cultivation is around 23 acres presently in Nawada village. In adjoining Gurwa village, farmers have taken to grass pea in 12 acres of land. Thus, cultivation of grass pea has picked up in this part of district Gaya.

13 | Moving ahead with Popularization of Grass Pea Cultivation in Bihar

There is a huge scope and prospect for grass pea cultivation in the state. Utilization of rice fallow for grass pea cultivation has opened up new opportunity of increasing their income. A leguminous crop, experts believe grass pea has all potentials of being bracketed among remunerative crops of the state. Increased production of grass peawould reduce the need of importing pulses through self-sufficiency in pulse production. A climate resilient crop, grass pea cultivation requires low input; consequently B:C ratio of grass pea cultivation is higher as compared to other legumes like lentil. The farmers have thus scope of increasing their profit margin by taking up cultivation of grass pea primarily because of low cultivation cost of the crop. In addition, nitrogen fixing capacity of the crop is an added advantage that helps in increasing yield of the subsequent crops. Popularization of value added products like*Bari*, Besan and extruded product (*Kurkure*) is encouraged for increasing income of the farmers. For landless farm women, 40-50 day old green leafy vegetable of grass pea is yet another source of earning. By selling leafy vegetable at rate of Rs 20-40 per kg in local market, they earn livelihood. In Bihar, mostly local cultivars of grass pea having ODAP content more than permissible limit are grown; hence there is huge scope for seed replacement with improved varieties of grass pea. Accordingly, Bihar Agricultural University has stepped up process for developing new grass pea varieties having low ODAP content taking into consideration need of farmers in state. The grass pea straw a good dry fodder for cattle, feed blocks are also prepared through value addition of straw.

14 | Conclusion and Way Forward

The Biotech-KISAN Project implemented by the Directorate of Extension Education, Bihar Agricultural University, Sabour with financial and technical support from the Department of Biotechnology, Ministry of Science & Technology, Govt. of India led to revival of cultivation of grass pea, once a banned crop.The estimated financial gain of Rs. 27,500/ha (Twenty seven Thousand five hundred/ha) per season through its cultivation in rice fallows. The farmers of three districts viz. Gaya, Lakhisarai and Patna came forward to adopt the new varieties of grass pea containing low level (<0.1%) of ODAP. The average yield of the new varieties was numerically higher and ODAP content was low as compared to local traditional varieties. Higher yield and low ODAP content helped farmers in attracting better price for their produce. Besides its use as pulse, the value-added products like Gahana & *Phul Bari*, extruded product, like *Kurkure* helped in increasing farmers' income significantly. In addition, Feed Blocks prepared from the straw of grass pea has opened a new avenue of increasing income coupled with reduction in shortage of fodder. Farmers have come forward to adopt cultivation of grass pea in a big way especially in rice fallows. This will bring smile on the face of thousands of farmers and their family and also contribute in reducing protein malnutrition by supplementing pulse production of the state.

It is now expected that the State Department of Agriculture of the Government of Bihar will take this technology forward and spread cultivation of grass pea in other districts viz.Aurangand, Navada, Jahanabad, Bhojpur, Rohtash, Nalanda and East Champaran of the state having sizeable area under grass pea so as to reduce shortage of pulses and fodder on one hand and help in substantial increase in the income of the farmers on the other.

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