1. CIP Annual Report

1.1 Germplasms for different objectives supplied to CPRI*:*

International Potato Center (CIP) supplied 118 advanced potato clones: 21 heat tolerant and low tropical virus resistant, 57 bio-fortified tetraploid clone rich in iron and zinc, resistant to late blight and major viruses, and 40 diploid clones for breeding purpose to develop varieties preferred by farmers, processors and consumers. The materials are currently multiplied for multilocation testing. Our objective is to release five locally adapted table and processing quality varieties in the next 5-7 year.

Return on investment: These new varieties are expected to cover 300,000 hectares with additional income of Rs. 20,000 per hectare.

1.2 Released Potato Varieties:

- **New potato variety, Kufri Lima, to take on heat and virus in India:**

A CIP clone 397065.28 released as Kufri Lima in 2017. Farmers will get 20% higher yield and profit with the release of Kufri Lima by planting one month earlier than other varieties (Figure 1). Early planting means farmers will be able to sell their produce at a premium price before market is flooded with harvest of other varieties. Farmers can expect to receive 40 to 50 percent higher price than farmers growing potatoes during the normal season. An added benefit is to provide a productive window to plant an additional winter crop, such as wheat, rice or other vegetables. Framers save money and improve environment by reduced use of pesticides as this variety is resistant to virus. This variety is expected to cover over 100,000 ha area in next 7 year when farmer start to receive seed in sufficient quantity

Figure1. Early and terminal Heat tolerant Kufri Lima

Return on investment: This variety is expected to cover over 100,000 ha area in next 7 year with additional income of Rs. 20,000 per hectare.

- **CIP clone 397006.18 recommended as drought tolerant variety**

A CIP clone recommended for variety release for arid and semi-arid agro-ecologies of Gujarat, Rajasthan, Madhya Pradesh and Chhattisgarh to grow potato in 25-30% less water without effecting tuber yield significantly (Figure-2). It is short duration variety with 20% dry matter and good keeping quality. Farmers will not have to invest for seed every year and can use for 2-3 generations as it is resistant to viruses.

Figure -2 Drought tolerant potato variety for dry and semi-arid regions

Return on investment: This variety is expected to cover 50,000 hectares with an additional income of Rs. 15,000 per hectare.

- **CIP Clone 304351.109 ready for 70 Day Red Skin variety for 15% of area under red skin varieties in India.**

A red skin CIP advanced clone early maturing (70-day maturity after planting) was selected and yielding 40.91 t/ha (marketable) and 43.02 tons per hectare showed superiority by margin of 11% over best control red (Figure 3). The clone possessed 20 % tuber dry matter and exhibited excellent keeping quality. The clone is resistance to viruses and moderately tolerant to late blight. Farmers and consumers both like red skin potatoes in Bihar, West Bengal, Odisha, North Eastern States and J &K. There is great demand of these States to have new red skin variety because exiting varieties are poor yielder. Earlier planting gives farmers the ability to sell their potatoes at a premium price. Early harvests give time to farmers to plant an additional winter op to enhance income. Release of this variety will enhance 30-40 productivity of N-E States and improve farmers' income by over 40% and expect to cover over 150,000 ha in 7 years after its release.

Return on investment: This variety is expected to cover 200,000 hectares in Eastern and North-eastern states with an additional income of Rs. 30,000 per hectare.

1.3 Decentralization of potato seed system

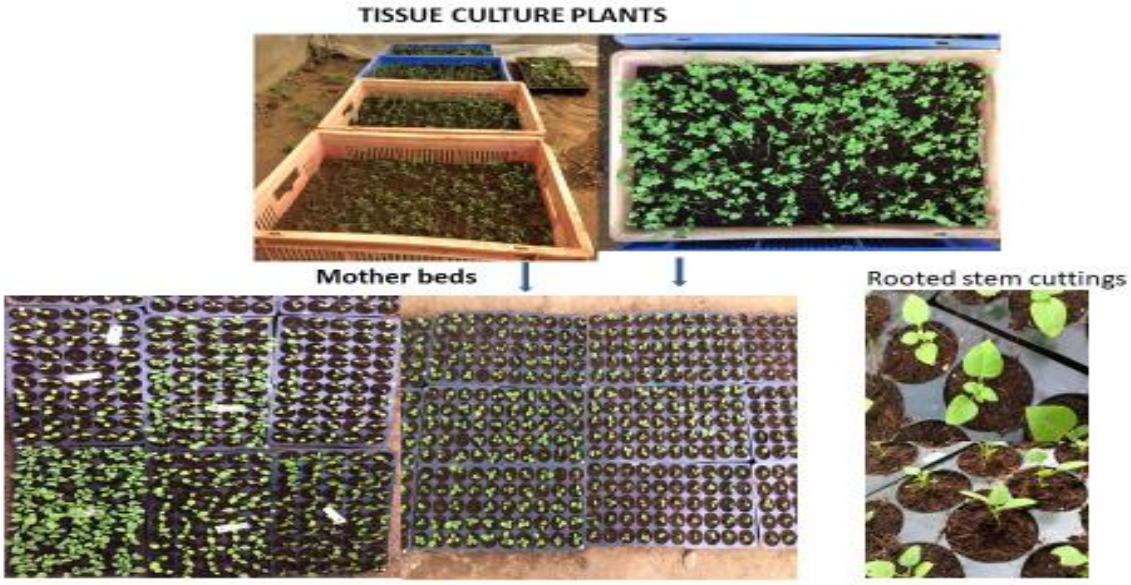
1.3.1 CIP introduced low cost temporary net house technology for State Governments to initiate sustainable quality seed production locally in States such as West Bengal, Karnataka, Maharashtra and Assam (Figure-4). Production of healthy locally produced seed will reduce

40% seed cost and enhance farmer's income by 50% through enhanced yield compared to seed imported from other states.

Karnataka Maharashtra West Bengal Maharashtra

Figure 4. Low cost technology to produce healthy seed in moderate climate

1.3.2 To supplement costly aeroponic system for basic potato seed production, CIP has innovated and introduced a low cost apical stem cuttings to produce basic seed adopted at large scale in Africa and Vietnam. Cost of one minituber would be about one rupee compared to 8-10 rupee produced through aeroponic. CIP/CPRI/ Department of Horticulture and UHS Bagalkot have started the feasibility study on commercial it in Karnataka, North-East and Assam



Apical rooted stem cuttings program take at Central potato Research Station, Shillong

Return on investment: Decentralization of seed system will allow progressive farmers and private entrepreneurs to take up seed production using apical rooted cuttings and temporary net houses. In the next five years, seed production in Odisha, Assam, Karnataka and Jharkhand is expected to increase to supply 20-30 percent of their own seed requirements with seed price declining by as much as 25-40 percent.

1.4. Small Farmers Large Field (SFLF) farming model: The SFLF model enables small and marginal farmers to achieve bargaining power and economics of scale by strengthening backward and forward integration along the supply chain, lowering costs, and improving efficiency by synchronizing and harmonizing selected key operations (such as nursery seed bed management, land preparation, transplanting, and harvest). The pilot experiment in Taraboisasan and Khanizpur hamlets near Bhubaneswar doubled the profitability of farmers by lowering cost of production (see annex 1 to get more information on the benefits of SFLF pilot model that was published in Indian Express on 29/11/2018. The SFLF model is currently piloted in Assam and Odisha to improve farmers' bargaining power by pooling resources and linking them to the market, together with CIP's experience in value chain development of potato.

AGRICULTURAL ECONOMICS

How doubling of farmers' income is possible even with small landholdings

A unique 'small farmers, large field' model experiment in Odisha shows the way forward for achieving economies of scale and reducing cost of cultivation

SAMARENDU MOHANTY & SAMPRITI BARUAH

INDIA'S POLICY focus recently changed from increasing farmers' output to their incomes. This is much needed, as farm profitability in India is among the lowest in emerging Asian economies. The strategies proposed for doubling farmers' income include planting better seed varieties/hybrids, improved production practices, diversification towards high-value crops, development of infrastructure and market linkages, and providing access to institutional credit. However, a major impediment to the success of these strategies is small farm sizes. NITI Aayog member Ramesh Chand, in a 2017 policy paper, advocated collective action for minimising the scale disadvantages faced by small and marginal farmers. The Farmer Producer Organisation/Company approach is one way to enable them to improve their bargaining power, by pooling resources and linking them to the market.

The Small Farmers, Large Field (SFLF) model is founded on the same principles of aggregation and achieving economics of scale, through strengthening backward and forward integration along the supply chain and lowering costs by synchronising key agricultural operations from field preparation to harvest. The SFLF was conceptualised in Vietnam in 2011. One indicator of success is the total area under it rising from 8 hectares to 196,000 hectares between 2011 and 2015. SFLF model has taken different forms in Vietnam. Some are formal, with farmers physically pooling their land and setting up companies that operate like private businesses. The shareholders here are farmers themselves. But there are also many informal SFLF entities, where in farmers have retained their individual holdings and come together only for synchronisation and harmonisation of select agricultural operations to improve efficiency and lower costs.

COST & RETURN FROM SFLF vs. NORMAL FARMING

ITEM	RABI 2015 - 16	RABI 2016-17
Yield (quintal/acre)	22	28 (average)
Price (rupees/quintal)	1250	1380
GROSS INCOME (rupees/acre)	27,500	38,640
COST (in Rs)		
Seed	320	320
Seed treatment	40	40
Nursery bed preparation	400	250
Land preparation	2400	2200
Irrigation	2000	2000
Crop establishment	2100	1900
Gap filling	400	400
Manual + chemical weeding	1050	790
Fertiliser + application	2500	2750
Pesticide	1400	870
Harvesting (machine hiring cost)	2500	2000
Storage cost	260	290
TOTAL COST	₹15,370	₹13,810
NET RETURN	₹12,130	₹24,830

In the 2016/17 rabi season, we piloted an informal version of the SFLF model in Taraboisasan village near Bhubaneswar. Our first exercise was to explain to farmers there the SFLF concept and its benefits. Many of them were not convinced; they felt that it would mean giving up the freedom to do farming on their own. However, some of the progressive farmers helped us in convincing their colleagues of the potential benefits from working together. Finally, 54 of the 90 farmers in the village agreed to participate in the pilot project. These farmers, with a combined landholding of 90 acres, selected an eight-member committee to coordinate with the project team.

The first significant decision the farmers made was to grow a single paddy variety and procure its seeds from a certified producer. In the previous season, they cultivated as many as five varieties and sourced the seeds from diverse entities. That included saved seeds of their own or taken from other farmers, and also fresh material procured from a government-owned agency or research institute.

The second step that the farmers took was setting up mat nurseries to prepare paddy seedlings in nine patches, with the largest one serving 30 acres. It took some effort to assemble the farmers into nine groups, based on their individual field locations, irrigation tube-wells, and relationship with one another. Earlier, the 54 farmers were individually raising nurseries on small pieces of land. That, as the secretary of the SFLF Committee Bimbadhar Biswal noted, made it extremely difficult for tractors to operate. Moving around within small pieces of land also consumed extra fuel, which wasn't the case now.

We worked with the committee to also line up input suppliers and service providers, to negotiate lower rates. The SFLF group assessed the fertiliser requirement of every farmer and placed a single order with the Indian Farmers' Fertiliser Cooperative (IFFCO). IFFCO was then induced to supply fertilisers at below its normal retail price and deliver it at the farmers' doorstep.

Before the season started, we invited local rice millers and explained our pilot project to them. They were willing to pay a premium for the paddy produced, due to the ease of milling a single variety. We further facilitated a meeting between a combine harvester service provider and the SFLF committee. He agreed to charge Rs 2,000 per acre, as against the Rs 2,500 rate that the same farmers had paid the previous season. The farmers also spent less on nursery bed and land preparation, crop establishment, and purchase of herbicide and pesticide. They incurred more cost only on fertiliser and storage of the harvested paddy. The expense on fertilisers was higher, despite lower prices negotiated with IFFCO, only because farmers believed that the high-yielding 'Bina 11' variety being grown by them required additional nutrients. They, therefore, applied more quantity of fertiliser than before. Storage costs, too, went up simply because the average paddy yield was 27 per cent higher, hence requiring more number of bags than earlier!

These farmers see the benefits of coming together

Before harvest, we contacted the same millers. The SFLF committee chose the one based on both the paddy price he was offering and his reputation. The price they got was Rs 1,300 per tonne higher than the prevailing market price. Based on data from each participating farmer at the end of the season, we estimated their average per acre profit at Rs 24,830, as compared to Rs. 12,130 in the 2015/16 rabi season.

But monetary benefits apart, there was also time and energy savings. The participating farmers were vocal about the time they saved by having group seedbed nurseries and synchronised transplanting. They also mentioned the time and money saved from fertiliser being delivered at their doorstep. In the 2017/18 kharif season, the number of farmers went up from 54 to 77, with many from the nearby hamlet joining the group. The total acreage, too, rose to 171 acres.

The above SFLF model seems an attractive option for small farmers to increase incomes. They are able to achieve scale through harmonising and synchronising select farming operations and enhancing their bargaining power in input purchases as well as output sales. But our experience suggests that the scalability of this model is not automatic. Any new group formed will require hand-holding, facilitation and technical support for one or two seasons. But once that is in place, it can sustain for a longer time.

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Return on investment: The SFLF farming practices is expected to double profitability of potato farming in Odisha and Assam because of lower cost and increased productivity.

1.5. Capacity Building

- A CPRI scientist trained on the bio-fortification programme of ICAR-CPRI and import of potato germplasm, for a 15 days training programme on standard operating procedures in bio fortification analysis organised in CIP-Lima
- To work jointly on developing and testing hybrid diploid potato varieties to be grown from true potato seed to reduce seed cost and have uniformity for tuber shape, size and colour, a 15 days training programme on various aspects of developing diploid potatoes a CPRI scientist was trained in CIP-Lima.
- Visit of two scientists from Assam was organized to visit the CIP research programs in CIP- Liam to attend World Potato Congress in Cusco, Peru

- Organised a learning program for Scientists of Department of Horticulture, Assam and University of Horticulture Science, Bagalkot, Karnataka on producing potato seed over 7000 MT in temporary net houses in North Bangladesh.
- Organized a learning visit of Scientists from University of Horticulture Science, Bagalkot, Karnataka to Vietnam on potato seed production taken by farmers by low cost apical rooted stem cuttings.
- Sponsored a scientist from CPRI to participate in Euro Blight (related to late blight) in Beijing, China
- More than 500 persons including extension workers of Department of Horticulture and farmers trained on best potato production including seed production. Also organized exposure learning visits of potato stakeholders among potato growing states

1. Involvements with the State Governments, domain of work and progress made;

CIP has been working in partnership State Departments of Haryana, Karnataka, Assam, to deliver sustainable quality potato seed production locally, 70 day robust abiotic and biotic stress tolerant potato varieties for rice/wheat based cropping system, implementing integrated health management practices for potato, low cost country potato stores for marginal farmers to get remunerative price of their produce, capacity building on apical in-vitro stem cuttings a low cost seed production technology to supplement a high cost aeroponic seed production system.

2. Future Plans

- **CIP will supply 1500 elite clones and parents for:**

i) Make crosses between CIP/CPRI parents at CPRS Kufri to develop new potato varieties for processing and export quality in next 5-6 years to benefit marginal farmers. This is urgent to bring new varieties.

ii) Import short duration elite clones for testing directly to develop heat, drought, virus and late blight resistant potato varieties for cereal based system.

iii) CIP/CPRI will work to develop potato cyst nematode resistant varieties for hilly regions of HP, UK and J&K as these states have been quarantined due to PCN problem.

iv) Import photo insensitive germplasm to develop varieties that can be grown both under short and long day conditions like Kufri Jyoti and Kufri Chandramukhi.

- CIP/CPRI will work jointly on developing and testing hybrid diploid potato varieties to be grown from true seed to reduce seed cost and have uniformity for tuber shape, size and colour. CIP will provide 6 month training to a CPRI scientist on hybrid potato seed development at CIP Lima and Huancayo research station in highlands.

- CIP will strengthen the germplasm preservation using cryo-preservation at CPRI by providing 2 months training at CIP, Lima to CPRI Scientist.

- CIP will work with CPRI scientist on genome editing of potatoes.

- CIP continue to work with CPRI, State Departments of Agriculture/Horticulture and State Agriculture/Horticultural universities on decentralization of quality seed production from seed producing to non-seed producing states to benefit farmers by timely availability of quality seed at lower prices. Cost effective apical stem cuttings from in-vitro plants for basic seed (minitubers) production will be evaluated and popularized in priority states such as West Bengal, Assam, Odisha, Jharkhand, NE States and Karnataka.

- CIP will scale-up Small Farmers Large Field (SFLF) model in partnership with appropriate ICAR institute, State Departments of Agriculture and Horticulture for sustainable intensification and raise farmers' income in eastern potato growing states.

3. Impediments faced in implementation of project activities;

CIP is satisfied with the support from CPRI, CTCRI, State Department of Horticulture/Agriculture, AICRP centres in implementing the programs of projects at different places

4. Expectations of CG Centers.

Potato is an important food crop in the North-eastern region comprising of eight states namely Assam, Arunachal Pradesh, Meghalaya, Manipur, Mizoram, Nagaland, Sikkim and Tripura. The region accounts for 7 percent of total national acreage but contribute only 2.3% of the total national production (source: Horticulture Statistics at a Glance 2018 published by the Ministry of Agriculture & Farmers' Welfare, Govt. of India). In 2017/18, it produced 1.2 million tons on an acreage of 155,000 hectares. Assam has the largest area in the region with two-third of the acreage and 60% of the total production. Overall, northeast is a potato deficit region where consumption accounts for 3.42% of the total consumption but produces only 2.48%. The overall potato productivity of region is about 10 t/ha compared to national productivity of 23 t/ha.

CIP in partnership with CPRI/ICAR want to make NE States as potato seed hub and offseason processing potato in next five years. These states can provide quality seed to seed deficit's State to West Bengal, Odisha and Jharkhand. To achieve this target CIP needs 25 crores budget from ICAR in five years (5 crores/year) from ICAR. CIP will also invest equally for this project.