SEED PRODUCTION IN THE DEVELOPING COUNTRIES: CIP STRATEGY

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Introduction.

Root and tuber crops have played an important role in feeding the developing world and will continue to do so in the future. It is estimated that by the year 2020, more than two billion people all over the developing world will depend on these crops for food or income. Many of them will be the poorest of the poor. The adaptation of these crops to marginal environments, flexibility in mixed farming systems, and the contribution they make to global food security makes them prime candidates for welfare activities targeted toward the poor rural communities. Current changes in food habits and emerging new products associated with these crops, provide new market opportunities for resource poor farmers. The projected growth rate in output for potatoes is particularly high at 2.7% per year, in comparison to wheat (1.5%) and rice (1.25%). This high output is directly related to the increase in area planted rather than an increase in output per unit area. However, in recent years, there has been a considerable slowdown in the rate of expansion of these crops, most probably due to the reduction in the land available for crop production, which is gradually decreasing due to urbanization and the negative effects of modern high input intensive agriculture. The unavailability of quality planting material at a reasonable price is considered to be the most important constraint for potato production in the developing world.

Seed systems.

Since the time man first domesticated plants, they have saved seed from their harvest for the next crop. They exchanged seed among themselves or with other tribes according to their customs and practices. This simple practice is the basis of the informal seed system, which is also referred to as the farmer based seed system or the traditional seed system. FAO reports indicate that 85% of global seed requirements come from the informal seed system, indicating its importance in world agriculture. In our target countries, more than 90% of the potato seed come from this traditional system.

Formal organized seed production activity is a relatively recent activity that was started in 1883 in the United States and which later spread among the more developed countries such as Holland, Australia and Canada over the last 75 years. Unlike the traditional seed system, the formal seed production activity is based on a complex interaction involving many institutions governed by appropriate legislation.

Until 1995, CIP seed production activities in our target countries was directed towards the formal seed system as a means of addressing the lack of seed. However, after 20 years of continuous effort, except for a few countries such as in Brazil, Uruguay, Chile and Argentina, our efforts have not achieved the success we desired.

The reason for this failure was mostly due to inappropriate legislation present in these countries, where the seed legislation did not reflect reality. Legislation kept all the institutions under an umbrella called the public sector and protected it without providing the private sector with any opportunity. The development of new varieties, selection, distribution and quality control standards were all under the public sector. In a workshop conducted in Mindanao, the Philippines two years ago, it was concluded that the existing legislation in The Philippines was the major bottleneck for the development of a sustainable seed system in that country.

Changing the legislation is a long process. The recent world wide economic changes have forced many institutions to change. New ways to do things are emerging in the target countries. The public sector now increasingly engages private seed growers to multiply seed. There is provision and even incentives for the private sector to participate in seed production and many local and international seed companies are active in many target countries. New developments are taking place in institutions dealing with quality control, while others are shifting to quality standards of multinational companies.

The public sector is now increasingly directing their efforts towards addressing the needs of the farmers. The variety release committees within developing countries are increasingly considering the farmers needs before a new clone is released as a variety. All these changes contribute positively towards addressing the lack of seed in a given country. However, in the correct sense, they are illegal. Providing the means of convincing national governments to change the seed legislation to suit a given country is an important step that we must all undertake in the near future. Similar activities are already underway, especially in worldwide IPM programs, to promote a more sustainable agriculture system with less application of pesticides to promote environmental conservation. However, the development of the formal seed system alone will not solve the severe lack of quality planting materials in the developing world. To address the seed issue, the new thought that has emerged and which CIP follow, is to combine the formal and traditional seed system in a given country to address the seed issue.

Improving the formal seed system.

There are two important reasons for improving the formal seed system. The first, which concerns CIP, is new varieties. As the guardian of the world potato germplasm, CIP is constantly engaged in the production of improved germplasm with desired characteristics. Therefore, a formal, organized seed system is required to channel these new improved varieties to the end user. Some argue, however, that the development of a formal seed system should not only be looked upon in light of new varieties, but also to produce quality planting material of existing local varieties.

The investment to develop the formal seed system can only be justified if there are improved varieties accepted by the farmers for seed multiplication and diffusion through this system. In the past, many improved varieties have failed in the farmer's field. This failure is mainly because of our negligence to consider farmers needs during the selection and release of new improved varieties. Our concern in the past has been to develop new varieties with improved characteristics such as late blight resistance or superior processing qualities, as is the case of the variety Igorota in The Philippines. However, the farmers identified many undesirable characters such as poor dormancy, rapid greening, a poor ratio between marketable and non-marketable tubers and many other faults.

CIP and our collaborating partners now take into consideration the needs of the end user in selecting new varieties from improved germplasm. This activity, the standard evaluation trials (SETS), is performed in-country with the active participation of the end user. In these evaluation trials, we also take into account factors such as the ratio between the marketable and non-marketable tubers produced by a given clone. It is an important characteristic upon which the traditional seed system is based. It is the non-marketable tuber, which is the seed for the future.

There are some who believe that the development of the formal seed system will only address a few varieties and thus drastically affect the bio-diversity of the crop in a given location. We at CIP encourage our local partners in seed production to also consider native or local varieties along with the improved varieties in the seed system so as to preserve bio-diversity and to give the farmer access to quality planting materials of both native and improved varieties. We have had excellent results in Bolivia by combining both native and improved varieties in the seed system. More than 25 native cultivars were cleaned up using meristem tissue culture and introduced into the formal seed system to make high quality seed available to the farmers. These seeds were then multiplied further using rustic seedbeds that were promoted by the PROINPA potato program. More than 600 tonnes of seeds were produced in nearly 2000 such beds built in the Andeas Mountain in Bolivia.

The second reason for improving the formal seed system depends upon the ability of the farmers to maintain and produce quality seeds of these improved varieties. In the tropical countries, the production of seed is difficult due to high disease and pest pressure. In addition to this, suitable land for seed production is not available. However, it is not a general rule that the farmers in these countries are unable to maintain and produce quality seed. In The Philippines, the progressive farmers who have access to information can maintain and produce seeds of cv. Granola for over 10 generations. The same farmers are able to maintain the seed of improved varieties for longer periods than the farmers who have no or little contact with the extension service (Figure 1).

Quality seed is expensive. It is only the big farmers who have the financial capacity to buy quality seed. However, even they do not usually buy all their seed requirements, but often, only a small quantity of seed, approximately 50 kg, which they then multiply for various generations to produce the ware potato crop. On the other hand, small farmers buy a few tubers usually 50-100 or rooted cuttings. The demand for seed, even for imported seed, in many countries is relatively low. For this reason, many seed importers now require the farmers to pay in advance for the seed. The risks involved in potato production, which include market factors, climactic factors and uncertainty in the supply of seed are some of the factors, which reduce the demand for quality seed in these countries.

Our survey data from the Mountain Province in The Philippines indicates the problems that farmers face in replacing their seed more frequently (Table 1). Factors such as high cost, lack of imports and non-availability refers to imported certified seed, while doubtful quality and lack of a clean seed source refers to the seeds circulating within the traditional seed system. In almost all the target countries, bacterial wilt is the biggest constraint to the field multiplication of seed.

Figure 1. The number of farmers and the number of generations' potato seed is multiplied in two municipalities of the Mountain Province of the Philippines.

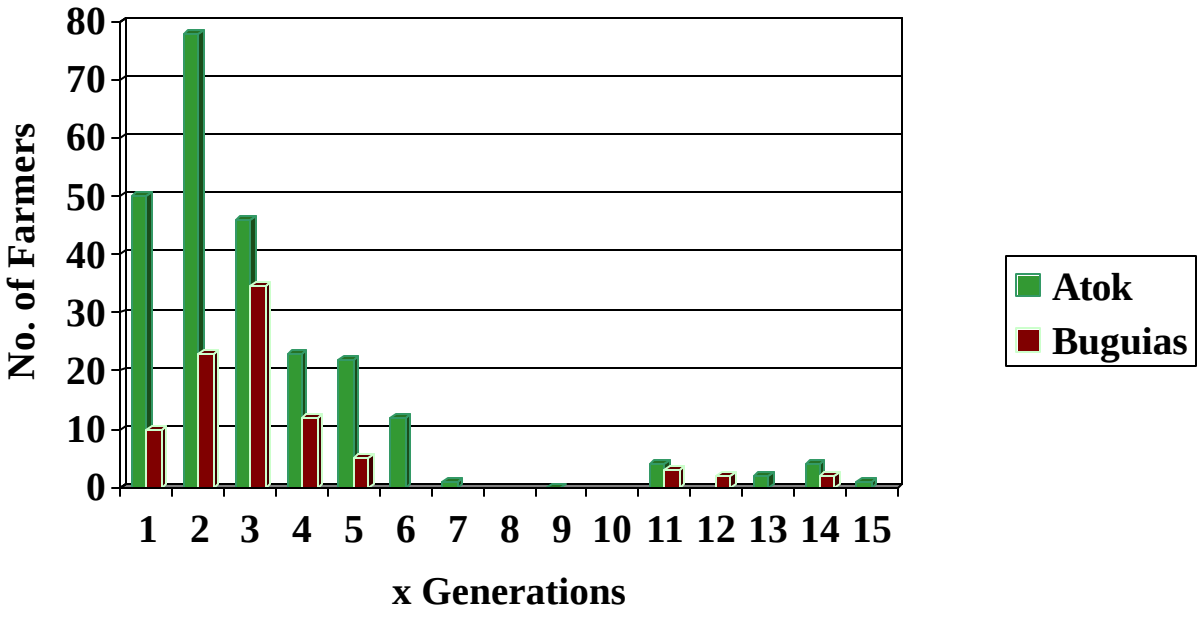


Table 1. Farmer's problems in acquiring quality seed. Mountain Province of the Philippines.

Problems	% Farmers
High Cost	41
Lack of Importation	14
Not Available	10
Questionable quality	10
Lack of clean seed source	8
Limited credit	6
Bacterial wilt	2

Many farmers are also not aware of the existence of new varieties. Therefore CIP, conjointly with our collaborators have adopted the following procedures to improve farmers awareness of new varieties in the Philippines;

- Early morning farmer programs broadcasted over the radio.
- Fliers and pamphlets.
- Demonstration plots and field days.
- Roadside advertisement as practiced by the chemical companies
- Information Caravan.

All of these methods have their advantages and disadvantages. These activities do increase the awareness of the new varieties and increase the demand for seed. However, if the cost of the seed is not within the financial capabilities of the resource poor farmers, the demand is not reflected at the farm level.

Strengthening the Formal seed system.

Where is the dividing line between the formal and the informal seed systems? According to the opinions of many, the formal seed system includes the public and private sector, NGOs, farmer associations, and all farmers who grow a crop with the intention of selling the whole harvest or a portion of it for seed. This also includes farmers who produce and sell cuttings. However, those farmers who sell whatever is left over after planting his field, belong to the informal seed system, since he had no intention of selling any seeds and it was just accidental.

In strengthening the formal seed systems, I would like to recognize the contribution ACIAR has made in the past through the regional network SAPRAD to CIP's seed production activities in the East and South East Asia and the Pacific Region. Some of the developments in Asia that I will mention were first initiated by this regional network which unfortunately ended about three years ago.

The current expansion of the fast food industry in the developing world has led to an increase in the importation of products and raw materials. However, the demand has often placed a serious drain on the country's valuable foreign exchange. This has led some national governments including Vietnam, Sri Lanka and Thailand, to allocate funds towards the development of facilities for the production of seed potatoes, while in others, the modest development in facilities has been partially funded from CIP core activities or special funded projects. Some of the facilities developed include; low-cost net houses for the production of G_0 tubers; modification and expansion of the tissue culture laboratories; development and implementation of equipment for soil preparation; training personnel in seed production activities in both international and national training courses; and implementing cost accounting systems for the production of seed potatoes. In the majority of the seed programs where we identified inefficient areas or high cost centers, we have implemented appropriate technologies to reduce the cost. In Nepal, the cost of in-vitro plants was reduced by the 26%, while in The Philippines, the cost was greatly undervalued (Table 2).

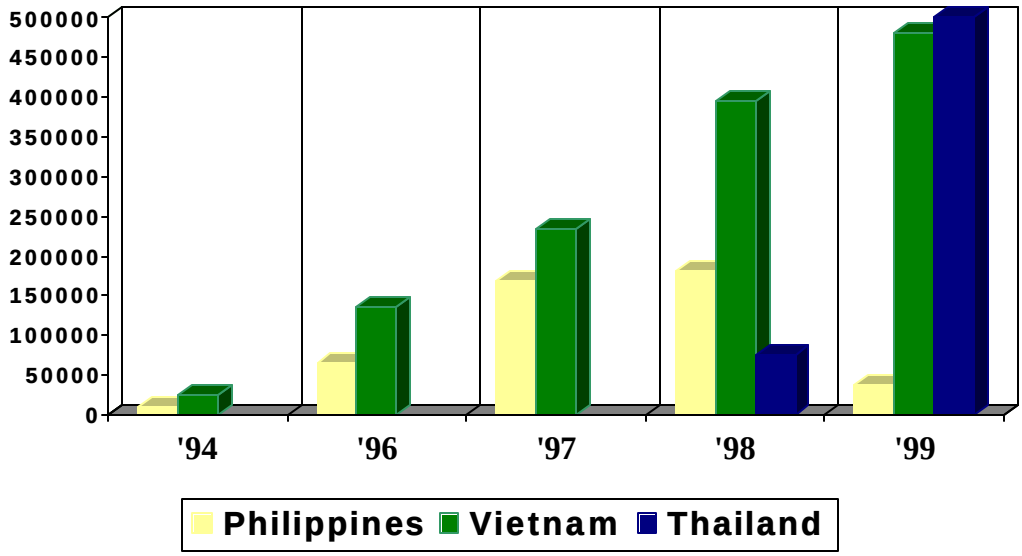
Table 2. The cost of clean potato planting materials produced by some of the national programs in selected Asian countries.

Country	In-Vitro*	Rooted stem cuttings (/100)*	G_0 /100*
Vietnam	0.14	0.30	6.4
Philippines	0.20	0.10	7.0
Nepal	0.15	NA	6.7
Thailand	NA	NA	11.0

* US$ (International market Price US$ 90.0)

Still some of the NARS in the target countries in Sub Saharan Africa such as Kenya, Uganda and Ethiopia depends entirely on CIP for the initial clean foundation plant material needed for seed production. During the last 5 years, the amount of clean planting materials, produced by target counties has increased dramatically (Figure 2). In The Philippines, however, the demand for cuttings decreased in 1999 due to the severe leaf-miner problems in the Mountain Province.

Figure 2. The quantity of clean planting materials produced by some selected National Seed program in Asia.



The availability of a small quantity of planting material in the form of tubers or rooted stem cuttings has not been sufficient. Therefore, various routes were tested for further multiplication. Our first choice in The Philippines was to engage, after training, village seed growers. It was a failure, since we were dealing with new varieties and seeds, which were sold or given only to his relatives or close friends. These farmers preferred to sell all the seed as a ware crop rather than to sell seed to his competitors. In Sub Saharan Africa and Nepal, CIP had more success with the private farmer seed produces than in The Philippines. In Nepal, success was achieved by organizing farmer seed producer associations for the multiplication of seed. These farmers were not only able to produce good quantities of seed, but were able to maintain seed quality by adapting their growing practices.

In the Andean mountain regions of Bolivia, farmer communities were involved in the production of quality seed using rustic seedbeds, developed and diffused by PROINPA. Nearly 2,000 such beds are in operation producing around 600 tonnes of seed per year.

The field multiplications just mentioned were directly related to the field multiplication of tubers of various generations. In countries such as Vietnam (Dalat), the demand is for rooted stem cuttings, mainly due to the low cost. In Vietnam, rooted stem cuttings are sold directly to the farmers by one producer who produces a million rooted cuttings per year. This activity was started about 20 years ago by the Biotechnology Research Center in Ho Chi Minh City which now has reached its peak and is able to supply the total seed requirement of the region. In The Philippines, due to the distance between the source of initial clean planting materials and the farmer, the municipality in collaboration with CIP established a rooted cuttings distribution center managed by the local farmer cooperatives. In the first year, they were able to produce about 8,000 G_0 tubers, which were then sold to the farmers. Starting this season, they will produce rooted stem cuttings for distribution. Similarly, two private farmers have built two net houses in the municipality of Loo and have already started to produce and distribute rooted cuttings in their respective municipalities.

There are many different approaches available for the further multiplication of clean planting material produced by the formal system. However, adapting any one of these techniques to a locality or a target country needs a good understanding of the traditional seed system. The involvement of the farmers in the multiplication of clean planting materials, produced by the formal system, is the first step in linking the formal and the traditional seed systems.

Linking the formal and informal seed systems.

Farmers acquire seed from various sources including the local market, seed traders, friends and relatives, or receive payment in-kind for helping in the field or collecting left over tubers from another friends harvest (Table 3).

Table 3. Farmers' seed source in the Mountain Province of the Philippines.

Methods	Farmers
Buy imported seed	8%
Buy from a reliable source (High elevation farmers)	27%
Buy or share with relatives and co-workers	30%
Receive as payment/ left over	30%
Exchange seeds and varieties	5%

In Bangladesh, the cold storage owners are the major source of seed for potato growers. However, farmers always prefer to acquire seed from the reputed village seed grower. The village seed growers are usually considered as a more reliable seed source and are usually farmers who are financially better off and able to store their harvest until next cropping season. These are then sold at a higher price. These farmers usually occupy a respectable position in the village, are members of the farmer associations if available, and many times, collaborators with the different institutes and extension services. Not always, but many have a farm at higher elevation which is used for the production of seed. They acquire basic planting materials either from the formal seed system or buy imported seed for further multiplications. Some of them have contacts with multinational seed companies and evaluate their varieties. Such farmers are an important node in the link between the formal and the traditional seed system.

Farmer practices to maintain seed quality can be divided into two groups; (i) seed replacement and (ii) seed management. Farmers are aware and do practice good procedures to maintain seed quality (Table 4).

Table 4. Farmer practice for maintaining seed quality. Mountain Province in The Philippines

Practices	Farmers %
Proper selection of site/area	34
Appropriate crop management	39
Careful selection at harvest	44
Proper storage	17

Some farmers in The Philippines buy small quantities of seed more frequently, even before his current seed show signs of fatigue. Thus, it is quite common to see different generations of the crop in the same farmer field. In the Mountain Province of The Philippines, seed replacement is usually five years. This however is variable according to the cultivar grown, distance from the market etc. In addition to these factors, variety and farmer knowledge contribute strongly to the length of time farmers can maintain appropriate seed quality.

Seed is usually stored in the house, under the bed, in the attic or in a small dark storeroom close to the house. Storage losses, up to 40% are quite common in these countries. Furthermore, many stored seeds are not of the correct physiological age at planting. The situation is even worse in countries such as Vietnam and China where the seed has to be stored for nearly 8-9 months under adverse conditions.

Diffused light storage, which was promoted by CIP in the early 1980's, seems to have disappeared from many countries, except those in Africa. There is a strong need for research and development in this aspect of potato production which forms the link between the past and future crop in the traditional seed system.

Strengthening the informal seed system.

CIP activities to strengthen the informal seed system in target countries depends on the local extension service. In many countries, the extension service is poor or non-existent. Therefore CIP have conducted various training courses for extension officers in Nepal, Pakistan, Bangladesh, Sri Lanka, Bolivia, and The Philippines. They in turn were useful in training farmer trainers for the farmer field schools which were organized in The Philippines, Pakistan, Bolivia, Nepal and Kenya (Table 5).

CIP has collaborated with the local national institutes to develop curriculum for the FFS. Special training courses for women have been held in Kenya and Bolivia and since the beginning of this year, the farmer field schools in Mountain Province (The Philippines) are targeting only women. This activity specially targets women since they play an important role in potato production and men usually don’t transfer the knowledge gained to women.

Table 5. The Number of farmers and FFS held in selected countries.

Country	No. of farmers	No. of FFS
The Philippines	820	33
Bangladesh	100	5
Sri Lanka	100	4
Nepal/Pakistan/Bhutan	425	18
Kenya	35	NA
Uganda	400	8
Ethiopia	144	4

In The Philippines, CIP utilized the existing system of vegetable farmer field schools to promote adoption, diffusion and seed production activities of new improved varieties. Two years after starting the farmer field schools in 1998, a survey was done to find out the effectiveness of adoption and the diffusion of new varieties through this system. Some of the major conclusions were;

- Farmer's criterion for the selection of new varieties was very different to our priorities.
- Among the farmers who attended the farmer field schools, 22% did not adopt the new variety.
- Two years after introducing the new variety, 29% of the area planted with potatoes was planted with it.
- 46% of the farmers bought planting materials from the formal system, while 54% acquired from friends and relatives.
- 42% farmers who did not attend the FFS adopted the new variety Igorota.
- 46% of farmers who attended the farmer field schools planted with new variety.

The results indicate a high rate of adoption by farmers who did not attend the FFS, indicating a strong influence from the informal seed system. However, we have been unable to determine whether this influence was directly due to friends and relatives who attended the FFS, whether it was because of heavy advertisement or whether it was the mayor of the municipality himself. The Mayor has an M.Sc in agriculture, he is a farmer and a regular speaker at the FFS. Thus he has tremendous influence among his people. The FFS did have some influence on the adoption of the new varieties since the farmers were able to observe and build the confidence that was needed for adoption. However, this confidence can also be developed using other means such as demonstration plots and field days. We have not yet had the opportunity to evaluate the effectiveness of FFS in farmers adopting improved crop management practices or the effect on traditional seed production.

The FFS in Nepal, however, were very effective in strengthening the farmer seed producer groups. Though the FFS has been an efficient tool in Asia with rice cultivation, we are still in the process of developing this methodology for potatoes.

The arguments for linking the formal and the informal seed systems are based on the following criteria.

- Farmers can maintain seed quality.
- The informal seed system can distribute seeds widely.
- There is an economically recoverable yield gap.
- The informal seed system is more efficient in selecting and diffusing new varieties.

All these four arguments were discussed earlier. The formal seed systems have an important role in this new concept**.** Both the formal and informal systems have qualities that can be linked to generate a more efficient seed system. The deficiencies of both can be identified and adequate intervention can be made to resolve the problems. For the formal systems, identification of the deficiencies is rather straightforward, but for the informal seed system, it is very localized and often requires a great deal of effort.

The methodology proposed and adopted for linking the two systems includes the injection of clean planting materials of new varieties into the informal seed system through identified places or nodes in the system. These include giving farmers small packages of seed for multiplication or utilizing seed growers, seed grower association, rustic seedbeds or other mechanisms.

The availability of a number of different methodologies is desirable, since the informal system itself is highly variable. Once the traditional seed system receives an adequate quantity of clean planting materials, it can be expected that the quality of the seed in this system will improve, provided that the farmers are taught to maintain seed quality through training and education. It is also expected that with additional knowledge, the farmers will improve seed quality control procedures adapted by them and that there will be a gradual shift in the seed system towards the formal seed system.

At CIP, we have already started this approach and all our activities relating to seed production are grouped into four categories to achieve our project goal, which is to

> *Facilitate the integration of improved germplasm and technical, legal, managerial and organizational interventions to improve the availability of low-cost, high-quality planting material to potato growers in less developed countries*

The sub projects are as follows;

1. *Identification of Constraints and Opportunities of Seed Potato Systems in Target Countries*. This activity provides data and justification for activities in other sub projects. The diagnostic work consists primarily of base line studies of selected elements of the seed systems of target countries.

2. *Identifying and Testing Interventions to Improve Seed Systems.* The strategy of this subproject is to strengthen weak components of seed systems in target countries. Activities depends on the data from baseline studies produced in the first sub project

3. *Production and Utilization of Hybrid TPS in Seed System*. CIP believe that TPS has great potential in the seed systems in the developing countries, especially in areas where certified seed is not available or very expensive and in remote rural areas where transportation is poor or lacking. This planting material is also a cheap alternative to clonal material when used to clean up soils infected with pathogens such as bacterial wilt.

4. *Evaluation and Dissemination of Promising Varieties.* Standard evaluation trials (SETs) are the basis of information gathering in this sub project, designed to acquire data on the performance of new genetic materials introduced into the country. The involvement of end users in the selection process is key element for the success of new varieties at the farm level.

Much has to be done to achieve total success and some considerations has to be given to the following aspects in seed production activities in the developing countries in the ESEAP and SWA regions;

1. Establishment of a working body to analyze and make recommendations to national governments to consider changing existing seed legislation to suit the reality.

2. Establishment or improvements in facilities for quality control procedures at a national level.

3. Research and development in seed storage

4. Development of FFS methodologies to suit potato cultivation

5. Research and development of components to control Bacterial wilt and Integrated Crop management.

6. Training in seed management

7. Implementing alternative techniques such as hydroponics technology for the production of G_0 tubers to reduce the number of field multiplication stages.

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