



Ministry of Foreign Affairs

Senegal Value Chain Study - Potatoes

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SENSE

Senegal Value Chain Study - Potatoes

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Preface

A promising future in agriculture

Senegal is expanding its food production with great ambition to serve consumers and spur rural development. Products of Senegalese farmers find their way to not only domestic customers but also to export markets in West Africa and the European Union. Dutch growers realized long ago that local circumstances are very favourable for the production of high-quality, nutritious agricultural products. The relative proximity to Europe and accessibility of the wider Sahel region make Senegal an attractive partner for close cooperation.

Partly due to climatic conditions, agriculture in Senegal certainly faces challenges, such as water scarcity and soil salinity. Dutch modern technology and expertise can support (further) improvement of overall performance and sustainability of production, post-harvest handling and marketing. It goes without saying that this will benefit Senegalese farmers to produce in a more sustainable, and profitable manner. Dutch innovative technologies could improve, for example, the use of quality seeds, precision agriculture, storage and packaging.

This 'scoping study' has analyzed those value chains in Senegalese agriculture to which Dutch expertise and technology can have the most added value for improved overall performance. In the framework of the study, a number of specific business cases have been developed, which could enable Senegalese and Dutch partners to cooperate (more) successfully. The overarching objective is to build a sustainable partnership between Senegal and the Netherlands around agriculture.

I thank the consultants of Sense for their good work. For more information on the study or advice, please contact our agricultural experts through DAK-LNV@minbuza.nl.



H.E. Mrs. Joan J.J. Wiegman
Ambassador of the Kingdom of the Netherlands to
Senegal

Préface

Un avenir prometteur pour l'agriculture

Le Sénégal développe sa production alimentaire avec une grande ambition de servir les consommateurs et d'accroître le bien-être en milieu rural. Au Sénégal les produits agricoles sont vendus dans les loumas, les marchés locaux, et sont également destinés à l'exportation en Europe et dans les pays de la sous-région. Depuis quelques années, des producteurs néerlandais ont investi le Sénégal pour la fabrication des aliments nutritifs de très bonne qualité et pour son personnel qualifié et engagé. Du fait de sa proximité géographique avec l'Europe et l'accès facile aux pays du Sahel, le Sénégal demeure une excellente destination pour les affaires.

Cependant, l'agriculture sénégalaise est confrontée à plusieurs défis qui l'empêchent de prendre son envol notamment l'amélioration de l'agriculture durable en plein champ, le renforcement des produits post-récolte, du contrôle de la qualité et de la commercialisation; l'utilisation efficace des intrants et réduction des pertes alimentaires dans la production agricole (gestion de l'eau, fertilisation des sols, utilisation des semences de qualité). De par leur expérience, les entreprises néerlandaises pourraient être un grand atout pour l'agriculture sénégalaise. En effet au vu de cette situation, les investisseurs néerlandais sauront contribuer à amélioration de la performance globale de la production et du marketing en utilisant des technologies modernes qui rendent l'agriculture plus attrayante pour les jeunes professionnels tels que les semences de qualité, l'agriculture de précision, le stockage et l'emballage des produits agricoles.

Cette étude de cadrage agricole a fourni une analyse de certaines chaînes de valeur stratégiques de l'agriculture sénégalaise où la technologie néerlandaise peut contribuer à de meilleures performances et à des positions considérables sur les marchés de consommation. Il a également développé des analyses de rentabilisation tangibles pour que les partenaires néerlandais et sénégalais coopèrent et créent conjointement des entreprises prospères. Pour de plus amples renseignements ou des conseils, vous pouvez communiquer avec nos experts en agriculture à l'adresse DAK-LNV@minbuza.nl

L'Ambassadeur des Pays Bas à Dakar
Son Excellence Mme Joan Wiegman

Executive Summary

The agro-ecological conditions in the Niayes provide just the right environment for potato production. So unique is the environment that this is one of only 4 countries in the region that are able to grow potatoes.

Local consumption of potatoes is small but growing. The short production season (winter) in Senegal and a limited use of storage does however mean that the country relies on both local production and imports to satisfy demand. Market protections introduced in 2016 limit imports to a period of 5 months of the year. Heavy tariffs and import quotas have been instrumental in ensuring that production develops. The area under production has expanded in recent years, along with yields and more recently the type of investors interested in potato production. The dedicated potato farm owned by Senegindia in Mbane is so large that it is possibly the largest potato farm in Africa. Good technical skills have meant that yields in some parts of the farm are in line with the continental leader, South Africa.

From the perspective of livelihoods, small scale farmers are able to profitably grow potatoes, with returns on investment of more than double that of onions. Expanding potato production thus has benefits for the balance of payments (Senegal is the largest importer of potatoes in the region), for livelihoods and importantly for national food security. As consumption in the region grows there are distinct environment and food security benefits for having production close to market.

If the goal is to expand the sector, then are some real opportunities to ensure that this is sustainable and more inclusive. This requires interventions in the seed system, which is poorly regulated and supplies seeds of unreliable quality- sometimes too late in the season. A second concern is that seed imports are so poorly regulated that diseases are introduced from what seems late generation seed from the EU.

Improving agricultural practices is another important area of intervention. Introducing mechanisation for land preparation and harvesting; ensuring that potatoes are harvested at the right time and using suitable techniques are all important measures to ensuring that farmers at all levels of scale and sophistication get good returns from every inch of valuable agricultural land and water being used to produce potatoes.

Sustainable farming techniques, which include better water and land management are all important ingredients to ensuring the longevity of the sector. This must include wide adoption of crop rotation and soil fertility management, especially on the larger farms.

Finally, there are opportunities to make this a more inclusive chain, that in particular creates space for women and youth. Mechanisation and agricultural services are two areas where youth particularly are able to carve out niches for themselves, without having to compete for space with established demographics. This is especially helpful if there are efforts made to ensure that skills training of these two vulnerable groups is practical and applicable in the real world, where financial products in line with their needs are developed and brought to their attention; where especially women are organised in groups to be able to take advantage of these opportunities and finally that mechanisation and irrigation services are developed to make this chain more attractive and practically workable for them.

As a powerhouse potato producer and the world's leading potato exporter, Dutch enterprise and knowledge institutes hold many of the essential skills, technology and resources needed to realise these interventions. Developing local production also fits with the strategic interests of the sector. This makes for a useful alignment of interests and an ability of the sector- commercial, financial and knowledge- to make a positive impact on the development of the potato chain in Senegal.



Résumé

Les conditions agro-écologiques des Niayes offrent un environnement idéal pour la production de pommes de terre. L'environnement est si unique que ce pays est l'un des quatre seuls de la région à pouvoir cultiver des pommes de terre.

La consommation locale de pommes de terre est faible mais en augmentation. La courte saison de production (l'hiver) au Sénégal et le recours limité au stockage impliquent toutefois que le pays compte à la fois sur la production locale et sur les importations pour répondre à la demande. Les mesures de protection du marché introduites en 2016 limitent les importations à une période de 5 mois de l'année. Les droits de douane élevés et les quotas d'importation ont contribué à assurer le développement de la production. La superficie de production a augmenté ces dernières années, de même que les rendements et, plus récemment, le type d'investisseurs intéressés par la production de pommes de terre. La ferme de pommes de terre de Mbane, propriété de Senegindia, est si grande qu'elle est probablement la plus grande ferme de pommes de terre d'Afrique. Grâce à de bonnes compétences techniques, les rendements dans certaines parties de l'exploitation sont conformes à ceux du leader continental, l'Afrique du Sud.

Du point de vue des moyens de subsistance, les petits agriculteurs sont en mesure de cultiver la pomme de terre de manière rentable, avec un retour sur investissement plus de deux fois supérieur à celui de l'oignon. L'expansion de la production de pommes de terre présente donc des avantages pour la balance des paiements (le Sénégal est le plus grand importateur de pommes de terre de la région), pour les moyens de subsistance et, surtout, pour la sécurité alimentaire nationale. Une production proche du marché présente des avantages évidents en termes d'environnement et de sécurité alimentaire, car la consommation dans la région est en augmentation.

Si l'objectif est d'étendre le secteur, il existe alors de réelles possibilités de faire en sorte qu'il soit durable et plus inclusif. Cela nécessite des interventions dans le système des semences, qui est mal réglementé et fournit des semences de qualité peu fiable, parfois trop tard dans la saison. Par ailleurs, les importations de semences sont si mal réglementées que des maladies sont introduites à partir de ce qui semble être des semences de dernière génération en provenance de l'UE.

L'amélioration des pratiques agricoles est un autre domaine d'intervention important. L'adoption de la mécanisation pour la préparation des terres et la récolte, la garantie que les pommes de terre soient récoltées au bon moment et l'utilisation de techniques appropriées sont autant de mesures importantes pour garantir que les agriculteurs, à tous les niveaux d'échelle et de sophistication, obtiennent un bon rendement de chaque centimètre de terre agricole, d'une grande valeur, et de l'eau utilisée pour produire les pommes de terre.

Les techniques agricoles durables, qui comprennent une meilleure gestion de l'eau et des terres, sont toutes des ingrédients importants pour assurer la longévité du secteur. Cela doit inclure une large adoption de la rotation des cultures et de la gestion de la fertilité des sols, en particulier dans les grandes exploitations.

Enfin, il est possible de faire de cette chaîne une chaîne plus inclusive, qui laisse notamment de la place aux femmes et aux jeunes. La mécanisation et les services agricoles sont deux domaines dans lesquels les jeunes, en particulier, sont capables de se créer des niches, sans avoir à rivaliser



avec la démographie établie pour l'obtention d'un espace. Cela est particulièrement utile si des efforts sont faits pour que la formation de ces deux groupes vulnérables soit pratique et applicable dans le monde réel, où des produits financiers adaptés à leurs besoins sont développés et portés à leur attention, où les femmes en particulier sont organisées en groupes pour pouvoir profiter de ces opportunités. Enfin, des services de mécanisation et d'irrigation devraient être créés pour rendre cette chaîne plus attrayante et plus pratique pour ces groupes.

En tant que principal producteur de pommes de terre et premier exportateur mondial de pommes de terre, les entreprises et les instituts de connaissances néerlandais détiennent un grand nombre des compétences, des technologies et des ressources essentielles nécessaires à la réalisation de ces interventions. Développer la production locale convient également aux intérêts stratégiques du secteur. Les intérêts seront ainsi mis en commun et cela permettra au secteur (commercial, financier et de la connaissance) d'avoir un impact positif sur le développement de la filière pomme de terre au Sénégal.

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1 Background and Method

The aim of this study is to provide insights into the Senegalese potato value chain and to define critical interventions that are needed for the sector to flourish. Ultimately it is hoped that these interventions will play a useful part in fueling an improvement in the livelihoods and food security of the Senegalese people, while improving the lot of women and youth and the environment.

More specifically the study aims to (i) describe the market, production and enabling environment in the potato chain in Senegal (ii) reveal the key issues, opportunities and bottlenecks in the value chain (iii) propose specific interventions that can help to address these bottlenecks & allow for the value chain to have greater impact (iv) identify areas where inclusive participation of women and youth in the economy can be stimulated (v) highlight opportunities for improved circular economy practices (vi) recommend areas where public, private and the knowledge sectors can make valuable, if not unique, contribution to these interventions.

The study involved 3 distinct phases. Firstly, desk research was conducted to understand the existing knowledge and open questions when it comes to the potato value chain. This was supported by interviews with subject matters experts. Generally, these were people, businesses or institutions who provide supporting services, knowledge development or institutional support in the agricultural sector in Senegal. To get a better understanding of Dutch expertise and strategic and commercial interests, interviews were conducted with businesses who trade with Senegal, professional sector organisations, research institutes or service providers who offer knowledge services in aid of Senegalese agricultural development etc.

In step 2 we carried out field research in the Senegal River Valley area as well as in the Niayes. This included visits to farmer groups, marketing platforms, financial institutions, the Senegal River Valley Development Authority (SAED) and industrial growers.

Finally, in step 3, field research was conducted with 75 consumers, 15 traders in 3 cities/towns in Senegal viz Dakar, Thiès and Pikine. 5 representatives from the Hotel restaurant and catering field (HoReCa) were interviewed in Dakar.

We must highlight that this research was carried out during the COVID 19 period, but after local constraints on travel were lifted. This has both advantages and disadvantages. A large number of interviews could be conducted telephonically, which made including a variety of perspectives and experiences from Senegal and the Netherlands far more possible. In some instances, the new “work from home” norm made interviewees more available. A downside was that research was carried out later than planned- outside of the key production period for potatoes. It also coincided with a major festival in Senegal. Nevertheless, access to farms, farming cooperatives and financial institutions were possible during the fieldwork- either face to face or via telephone or video calls. These greatly enriched the quality of insight reflected in this report.

2 The Market

Compared to the world average of 33 kg per capita per year the consumption of potatoes in West Africa is low. In 2020 Senegalese are estimated to consume just 22% of that volume per person.

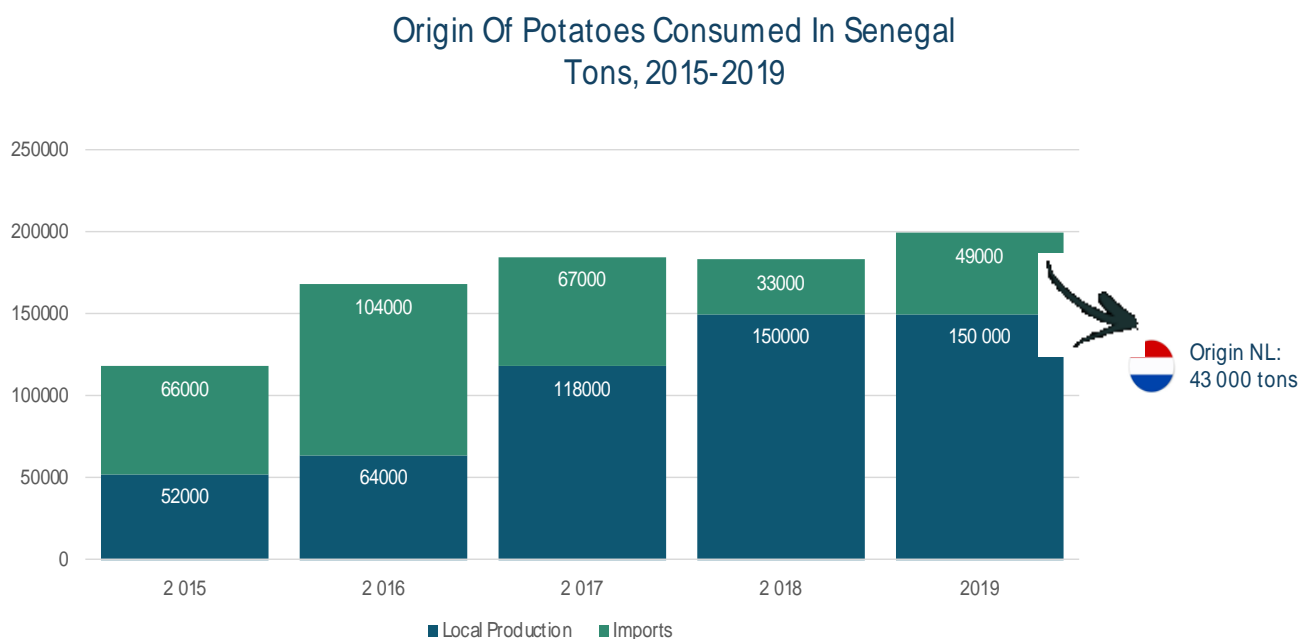
Yet, potato consumption is increasing. Where in 2011 they consumed on average of 6 kg per person, this has grown to 7.4 kg per person in 2019¹.

Most potatoes are consumed 'fresh' directly by consumers and restaurants and caterers. Larger potatoes tend to be distributed around the country, while baby potatoes are sold in the farming area. There is very limited processing, mainly potato crisp production on a small scale. Potatoes also play a small role in the food services sector, which in itself is still in the early stages of development. The first KFC arrived in Senegal in October 2019. In short, the market is still young and has a lot of space to develop.

The demand for potatoes is year-round, with a few peaks around key festivities such as Tabaski, Korité and Ramadan. In contrast, potatoes have a very limited production window. Potatoes require cool temperatures, which makes this a winter-spring crop in the Niayes. As a result, imports are required in the hot summer months. The quality of imported potatoes is seen as being somewhat better than that of local potatoes, largely because they can be stored for longer periods without rotting.

Strong import protections were put in place to stimulate local production. Import tariffs of 42% have been introduced and imports are only allowed when local producers are unable to supply the market. Typically, imports are allowed between July and January- roughly 8 weeks after the local late season crop has come to market. Local production has also been supported by heavy subsidies on potato seed.

Figure 1: Consumption, Import and Local Production of Potatoes in Senegal



Consequently, imports have decreased when compared to the highs experienced in 2015, 2016 and 2017. Currently Senegal produced an estimated 199,000 tons of potato, of which 150,000

¹ <https://www.helgilibrary.com/indicators/potato-consumption-per-capita/senegal/>

(75%) is produced locally. Nearly 88% of the 49,000 potatoes consumed is imported from the Netherlands.

2.1 Regional Export Opportunity

Consumption of potatoes in West Africa is still low by global standards, but growing. To cater for this demand both local production and imports have increased. Figure 40 provides an overview of consumption and imports in the region.

Figure 2 Imports and Per Capita Consumption of Potatoes in West Africa

	2019	Share of Regional Potato Imports	Consumption per Capita 2015*
ECOWAS	143 000 tons		
Senegal	49000 tons	34%	7.4kg
Ivory Coast	39000 tons	27%	0.83 kg
Mali	21000 tons	15%	7.34 kg
Burkina Faso	9000 tons	6%	0.29 kg
Cape Verde Islands	8000 tons	6%	Unknown
Togo	2400 tons	2%	0.39 kg
Ghana	2200 tons	2%	0.140
*Source: Helgi Library based on data from FAOSTAT			

The leading importers of potatoes in the region are Senegal, the Ivory Coast and Mali, who import three quarters of the total imports of the region. The biggest supplier is the Netherlands, followed by France and Belgium. Minor volumes are imported from South Africa and Morocco. Morocco is the most recent supplier of potatoes to the region, with most of these going to Senegal.

Regional potato production has also been expanding. In 2019, ECOWAS imported 11500 tons of seed potato, nearly 4 times more than in 2015 (3359 tons). Mali, Nigeria and now Senegal also have developing potato seed multiplication. But production of potatoes in the region has limitations. They require a temperate climate for production, with noticeable differences between night and day time temperatures. The lower the temperature, the better the tubers grow and the lower the disease pressure. Potato is a very disease prone crop, and benefits from production in dry climates under irrigation. Whereas East Africa has more highland areas with temperate climates, these are very scarce in West Africa. Most areas have a combination of humidity with high temperatures day and night (coastal zones), or dryer climates but with extreme heat during the day (Sahel) and are thus not suitable. This presents a unique opportunity to Senegal, where cool temperatures in the Niayes region provide good growing conditions for potatoes in winter.

Across Africa and particularly West Africa there are very limited zones with the right conditions. Potatoes produced in those areas tend to be transported over vast distances to reach consumers. Nevertheless, Intra-regional trade in ECOWAS when it comes to potatoes is still relatively small when compared to imports from the EU. 2000 tons of potatoes were exported from Mali to Ivory Coast in 2019, which could be imported European potatoes. In contrast, the tight controls on the

import volumes with growing demand mean that Senegal exported a paltry 265 tons of potatoes to Ivory Coast and Mauritania combined in 2019².

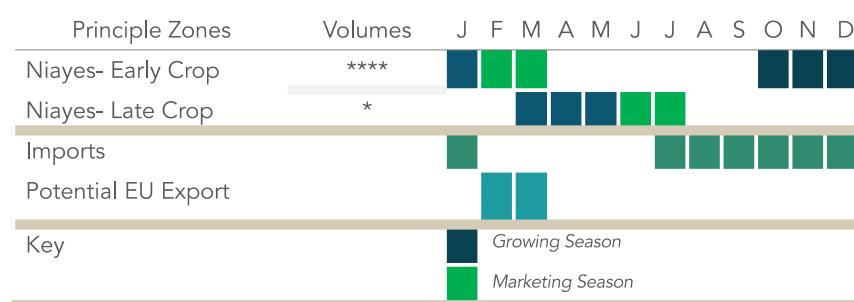
2.2 EU Export Opportunity

Export to the EU could constitute a market for Senegalese potato growers. The potatoes harvested in February could hit the shelves in Dutch supermarkets in March. This is when domestically stored stocks are running low and have been deteriorating in quality. Also, this would arrive 4-6 weeks before potatoes from Morocco and Egypt arrive. This would require experiments with different varieties to get the quality and timing right.

2.3 Overview of the Production, Marketing Season And Pricing

There are 2 potato growing cycles in the winter season. For the early season, potatoes are mostly planted from early October towards early November and marketed from late January until the end of March. In March the second growing seasons starts, and those potatoes are marketed in June and July. When they run out, the imports start until the new harvest in February of the following year. There is a small potential export window to the EU in February and March.

Figure 3: Overview of Sales Months and Export Seasons for Potato In Senegal

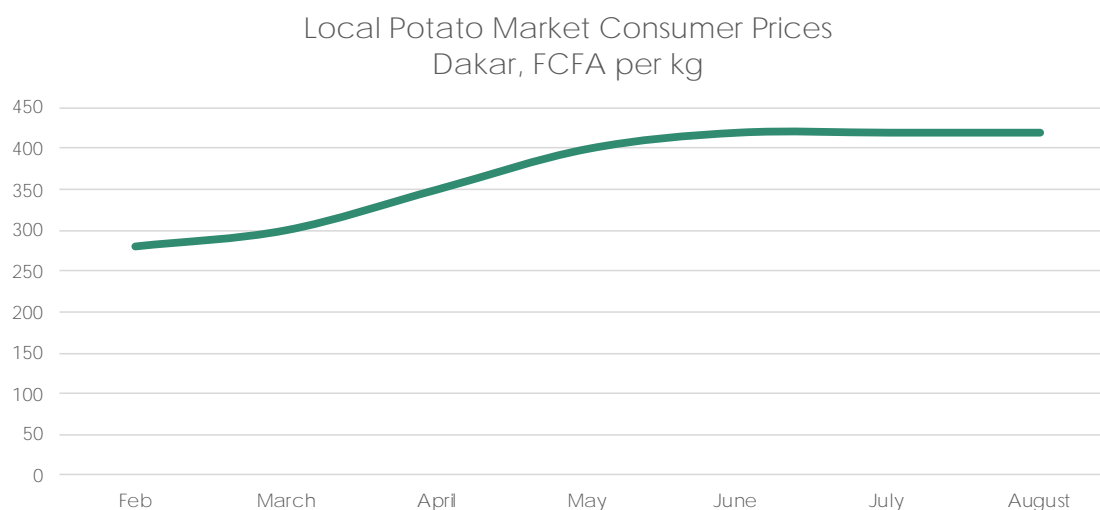


Consumer Market Prices of potatoes start at the season low in February (250-280 FCFA) . Then these price increases until a maximum is reached in June (420 FCFA). Finally, at the end of August the import ban is lifted, and potatoes are able to arrive from the EU.

Figure 4 Price of Local Market Potatoes - Dakar 2019

² Recorded exports from Senegal to Mauritania were substantial in 2018 , when 841 tons of potatoes were exported. But this seems to have been limited to that year. Source ITC Trade Map





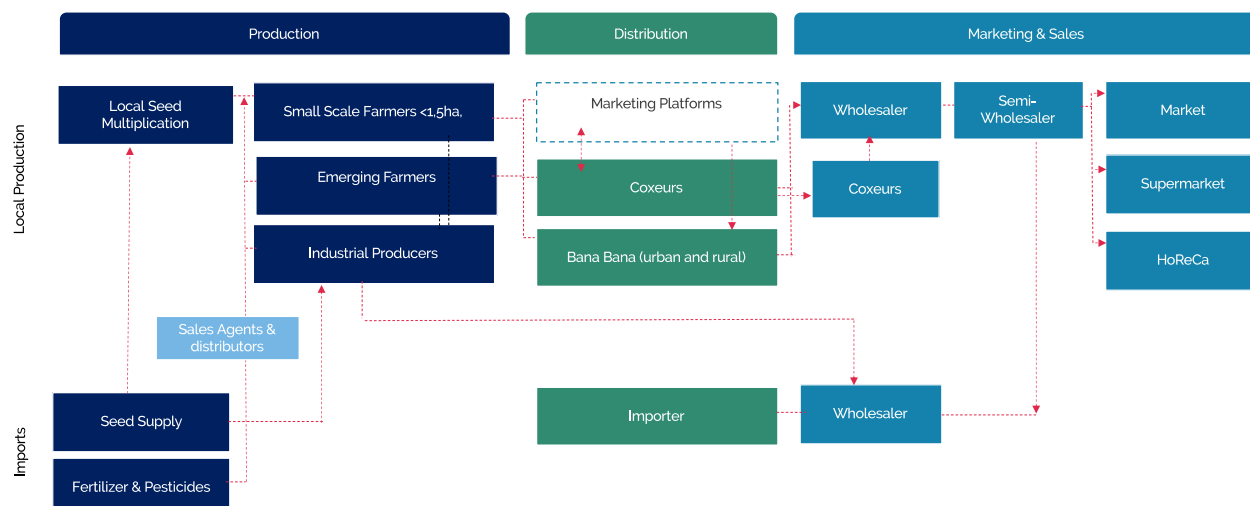
3 The Structure of the Value Chain

3.1 Overview of the Value Chain

Figure 43 provides an overview of the potato value chain in Senegal. Most inputs including seed are imported, though small quantity of seed is allegedly multiplied locally. There are 3 types of producers: small scale, emerging and industrial or large producers.

The complicated part is in the distribution. The two main actors are coxeurs and bana banas. Coxeurs are a type of marketing agent who is often connected to a specific production area where he/ she has his network of farmers. They don't tend to transport product or take ownership but receive a commission per kg. They act as a sort of co-ordinator of sales for either bana banas or wholesalers. Bana banas are more traditional traders who take ownership of the product and transport it. A small number of potatoes are now also traded via newly established marketing platforms and collection points. These are modelled after the onion chain. But this is a relatively new idea and still needs lots of development to be a major linkage in the chain.

Figure 5: Overview of the Potato Value Chain in Senegal



3.2 Production Locations and Yields

Potatoes are grown in the cooler North-East of Senegal and specifically, the Potou, Louga regions and presently a little further North in Mbane, on Lac du Guiers. Cooler temperatures in the dry winter months of 22-26°C create good conditions for potato production.

Growth in potato production volumes has come from an increase in the area under cultivation, as well as some smaller increases in yields. In 2010, 750 ha were being used for potato cultivation. Today that area has grown to 3356 ha. Nearly half of that area (1500 ha) is now farmed industrially in Mbane, which has become an important location for potato production.

This industrial production has allowed for a significant increase in yields in Senegal. Local small-scale producers, who still make up the vast majority of potato producers in the area, have yields that vary from 15-25 tons per ha. More advanced emerging farmers and industrial producers generally have yields of 25-30 tons per hectare depending on the variety of potatoes being farmed on a specific block. And the industrial producer Senegindia has achieved yields of 50 tons per ha on specific blocks in the previous production season. These yields are high for African standards, where small scale farmers typically achieve yields of 5-10 tons, and emerging farmers 8-15 tons. In South Africa dry-land potato yields are around 35-40 tons per ha and irrigated yields are 45-60 tons per ha.

A number of French potato varieties are grown in the Niayes, including Spunta, Sahel, Defla, Saffron, Alaska, Loanne, Panela and Claustar. These are produced in 2- and on rare occasion 3- production cycles, starting in November. The first harvest is usually in February and March, with another production cycle usually beginning in April and completed in June. Figure 44 provides an overview of the months in which potato is marketed.

3.3 Type of Producers

3.3.1 Large Industrial Producer

Senegindia, is the largest producer in Senegal and possibly has the largest potato farm in Africa by area. They produce >60 000 tons of table potatoes annually (40% of national production) under irrigation on about 1500 hectares. The water is drawn from Lac du Guiers, which in turn is fed by the Senegal River.

With better farming practices Senegindia targets the end of the growing season, or festivities, when prices are slightly higher. In part this is influenced by state policies to avoid competing with smaller local producers who are less flexible in when they can bring product to market. Senegindia thus relies heavily on storage. The installed capacity of storage at their facility is 40 000 tons (refrigerated and climate controlled), which allows them to store most of their crop for several months.

Senegindia has achieved an average yield of 25-30 tons/ha, with more recent peaks of up to 50 tons/ha in the 2019-2020 growing season with specific varieties. As a result, Senegal is potentially amongst the highest yielding potato growers in Africa after South Africa. Yields in South Africa are 35-40 tons for dryland farming and 60-70 tons per ha for irrigated farming. Yields in the Netherlands and Belgium for rainfed potatoes fluctuate between 40 and 65 tons per ha, depending on the variety and the weather.

In addition to their own production, they also engage contract farmers in an outgrower model. The producers purchase inputs from Senegindia. In some cases, this involves Senegindia providing prefinancing. Then at the end of the growing season they sell the potatoes back to Senegindia at the pre-arranged price. This offers the farmers some predictability around the sales price as well as quality inputs. But the farm gate price paid is close to the seasons' lower prices from the start of February.

Both emerging farmers and small-scale farmer cooperatives of various sizes take part in the contract system.

Figure 6 Overview of Financials of the Outgrower Model

Illustrative model of Senegindia's Outgrower model based on experience of a cooperative in the Niayes, 2019/2020 Season				
Cost of Inputs	Farm Gate Price	Cooperative Margin	Senegindia Purchase Price	Early Season open market Farm Gate Price
Pre-financed by Senegindia	200 FCFA	10 FCFA	210 FCFA	150-180 FCFA (early season) 300 FCFA (late season)

3.3.2 Emerging Farmers

There are a few up and coming emerging commercial potato farmers. These farmers are typically more technologically enabled and have farms that are larger than those typically farmed by small-scale farmers. They use about 2-3 pivots per farm for irrigation and may borrow planters from Senegindia to allow for some degree of mechanisation. With access to good quality inputs, irrigation and some mechanisation, they are able to deliver a good quality potato to market and achieve good yields similar to Senegindia's historic 25-35 tons per hectare. Many of these farmers cooperate with Senegindia, or are a part of their contract farming system.

3.3.3 Small Scale Farmers

Small scale farmers in the Niayes region typically have farms of less than 1ha. But some can be as large as 5ha. Typically, small scale producers have yields that range from 15 to 25 tons per ha, with the higher yields being reached on farms with good control of irrigation.

Potato is the main winter season crop for these farmers, alongside an assortment of vegetables such as cabbage, onions and carrots. Typically, 80% of the potato crop is grown in the first cycle between October and March. Thereafter, peanuts, onions or tomatoes would be grown under irrigation, or they could opt to close the winter growing season.

The rotation is guided by the market results from the previous year. If the previous year worked well for a crop, producers do it again. If not, then they change what they grow. There's also an element of "follow the leader" at play. Successful crops in one year get far more attention from more farmers in the next year. Prices then go down, which has the opposite effect.

Mechanisation is still unusual, albeit growing in usage. In general farming remains fairly manual or traditional farm equipment could be used. For example, planting, harvesting and even irrigation might be carried out by hand by hired labour (sorghas). When it comes to irrigation, which is required in the Niayes, flood or gravity irrigation (canals and diesel engines for pumping) is often used. This hampers their control over the growing conditions and increases disease spread.

Even on this small scale, potato farming is considered quite profitable, potentially more than onions. Indicative calculations suggest that small scale farmers are able to achieve roughly a 50% gross margin, which is significantly higher than that for onions (20% GM). This is consistent with our experiences in other countries, which have shown that those farmers who can manage diseases reasonably well and use good seed are very profitable.

At harvest these farmers employ migrant labour (sorghas) who come from Mali, Mauritania or poorer parts of Senegal. This labour then helps to bring in the harvest. Bagging of the potatoes generally occurs at the farm unless the farmer is a part of a cooperative. In that case the potatoes are taken to a central location for sorting and bagging. Farmers usually use 25kg mesh bags. Most harvesting is done manually, which tends to reduce yields because not all potatoes are uprooted and harvested.

3.4 Input Supply

3.4.1 Importance and Characteristics of Seed Potato

Potato is a unique crop in a sense that the quality of the seed (the seed potato) has an unusually large effect on yields and diseases and final product quality. The cost of good seed potato is



usually 40% to 50% of all input costs, despite potato requiring multiple rounds of preventative spraying and fertilising.

Furthermore, there is an enormous amount of potato varieties that differ in:

- Shape (round and oval, small and large).
- Cooking characteristics (Firm versus mealy or floury).
- Skin colour (red versus yellow).
- Flesh or inside colour (White to yellow).
- Sugar content.
- Potential Usage as a result of the characteristics (fresh table, mash, starch production, frozen chips, crisps, dehydrated) as well as the growing conditions.
- Storage period (how well and long can it be stored), and related to this the dormancy period (how long can the seed potato be stored before it starts sprouting).

One typical seed potato firm will market more than 50 varieties.

Good seed potato can be used for 3 years, meaning that for 3 years potatoes from the harvest can be kept aside for the next crop. Many commercial farmers will buy a certain amount of seed every year to refresh the seed stock that is now 3 years old.

However, whether seed can be properly re-used depends on the climate, the storage conditions and the dormancy period of the variety. For example, in the Kenyan or Cameroonian highlands farmers can farm 2 to 3 seasons, and the climate is temperate. Farmers can relatively easily store potato in a diffused light store (dark traditional storage with good ventilation), for 2-4 months until a next season starts.

But in Senegal re-using seed would require storage for up to 9 months in hot weather until the next season, which is not easy. It needs to be stored at temperatures from 1°C - 4°C to avoid early sprouting. The cost involved may well make it cheaper to just import new seed.

3.4.2 Oversight & Regulation

Potato seed falls under the control and legislation designed for seed, such as maize, rice and onion. As such, multiplication of potato seed is overseen by the Seed Division (DISEM) who is responsible for issuing permits to import and multiply seed. At the regional level field checks are tasked to the Regional Directorate for Rural Development.

Seed research and development is managed by the Centre for Horticultural Development (CDH) from the Senegalese Research Institute (ISRA). Finally, imports are regulated by the Directorate for Vegetable protection, who tasked to ensure that seed entering the country is free from disease and is in a good condition for sale.

In the past new varieties were studied by the state research institute, ISRA, before being approved and disseminated by them. Now producers, especially larger ones, import seed directly. They then carry out their own field tests, applying for authorization from DISEM.

3.4.3 Formal Seed Provision

Because it is nearly impossible to keep potato for a year to use as seed without cold stores, farmers, irrespective of the scale of production, rely on seed from the private sector. When it comes to small producers, seed is supplied under the state subsidised seed program, which allows farmers to purchase seed for 50% less than the market price. In 2018 this program provided an estimated 10 444 tons of potato seed to small scale producers. However, even this seed is made available via commercial enterprises, who import the seed from France.

Figure 7 Average Market Price of seed potato

Potato Seed, 28/ 55	
Retail Price (Import)	680 FCFA/ kg
Subsidised Retail Price (Local)	340 FCFA/ kg

Seed potatoes is sourced primarily from 2 French firms, Germicopa and Copec³. A far smaller volume comes from India, Egypt and the Netherlands. Figure 46 provides an overview. In a clever move, Germicopa distributes through one of the more active market gardening professional associations in the Niayes, AUMN.

In general Senegalese shoppers prefer larger sizes of potatoes (consumer research). But producers prefer smaller production sizes, which allow them to pack potatoes more densely per ha. Larger potatoes generally ask for more mechanization for harvest. But this also means wider spacing between the rows in Senegal. However, for mechanical harvesting and spraying, tractors can be fitted with narrow tyres to allow for narrow spacing. Local professional association AUMN for example advises small scale farmers to plant with a 50cm distance between rows.

Figure 8 Main Sources Of Imported Seed Potato In Senegal In 2018

	Volumes 2018	Share of Potato Seed Imports
Total Imports	8 100 tons	
France	6 000 tons	74%
India	676 tons	8%
Egypt	487 tons	6%
Netherlands	206 tons	2.5%

Well known seed suppliers in Senegal are Tropicasem, UPGM de Mboro (importing seed potatoes), AUMN (Association des Unions Maraîcher des Niayes) and Germikopa. Senegindia, who are a large importer of potato seed, supplies seed to contract farmers in their system.

More recently, Senegindia have been making steps towards local certified seed multiplication. But as this is still in the early stages that at present reserve a portion of the harvest, which will be used as seed in the next growing season. To keep the potato seed dormant, they use modern technologically advanced climate-controlled cold-storage facilities. This enables them to reduce the potato seed tubers they're required to import each year with two thirds.

ISRA has attempted local potato seed multiplication. Technically this is possible in climates with temperatures below 20°C and humidity below 30%-40%. The project faced a few challenges. Firstly, a virus attacked the seed which resulted in poor productivity rates. As second challenge is the cost of cold storage. The seed produced in January, February, March is required to be stored & kept dormant until planting in October. But an unstable electricity supply means that this is challenging and potentially costly. Local potato seed multiplication is yet to be successfully carried out. Yet, with 50% subsidies on seed, it would seem to be potentially beneficial to the state as well as offering some export opportunities.

3.4.4 Fertiliser & Pest Control Products

Fertiliser and pest control products are all readily available in Senegal via a privatised model of import and distribution. However, there is state subsidy of 50% on fertiliser for specific food security related crops like rice, maize and sorghum, but not potato.

Phosphate, which is critical ingredient in fertiliser production, is mined in Senegal. However, privatisation of ICSCHEM, the state-owned company responsible for producing fertiliser has resulted in this key mineral largely being exported to India, Iran and Japan. This focus on export of the primary commodity has resulted in a decreased blending capacity for fertilisers. Only 1 company blends fertilisers in Senegal on a limited scale. Consequently, commercial fertiliser is largely imported in pre-packaged bags.

This reliance on international suppliers means that standardised variations of NPK, DAP and Urea are readily available, but not specific blends for specific crops and areas. Some imported fertiliser comes from regional blending plants in Ghana and Ivory Coast. Commercial farmers in this region use DAP and NPK as well as potassium as fertiliser, as well as various pesticides to control disease.

Two types of importers compete in Senegal. Firstly, those that participate in the state subsidised fertiliser system e.g., Agriphytex. And secondly, those that are not allowed to participate e.g., La Cigogne.

Importers engaged in the subsidy program retail unsubsidised fertiliser directly to producers of potatoes. While the ones outside of the system market their products via independent agricultural supply retailers, who generally travel to Dakar to purchase and collect product. Increasing competition has led some companies to develop more defined business relationships. For example, they are offered wholesale pricing, delivery, area exclusivity agreements, technical training etc. Nevertheless, the enhanced- some would say unfair-competitiveness of the companies in the subsidised program means that most importers tend to prioritise pest control products over fertilisers.

From experiences across Africa, we know the fertiliser subsidies can have positive and negative effects. The positive effects are that it stimulates the usage of fertiliser and thereby boosts yields significantly. Small farmers particularly across Africa have a tendency to only use 1/3rd to ½ of the recommended dose because of a lack of funds, but this reduces the yields and profitability significantly. Negative effects that are observed, are:

- substandard quality of fertiliser, because governments rarely check the quality and farmers are less critical of free or subsidised fertiliser.
- Crowding out of the private sector, if only certain importers are selected for the scheme, as well as animal manure.



- Diversion of fertiliser intended for priority crops to non-priority crops, which in turn hampers the development of crop specific mixes.
- Late application of fertiliser because of late fertiliser distribution.

Finally, farmers also source animal waste (livestock, poultry and food compost) for use in potato production. A 50-kilogram (kg) bag of organic livestock- based fertilizer costs about 650 FCFA (while poultry-based fertilizer costs 1,750 FCFA⁴).


Figure 9 Cost of Fertiliser- Industrially Produced and Local Organic Fertilisers

NPK (10kg bag)	DAP (10kg bag)	Poultry (50kg bag)	Animal Livestock (50kg bag)	Compost (Casuarina tree) per wagon
1200	1400	1750	650	2000
These are typically used in potato production with cooperatives				

3.5 Route to Market

Imported and locally produced potatoes are available on the Senegalese market- albeit at different times of the year. Generally, imported potatoes are more expensive and their storability is better.

Figure 10, Average Market Price of Potatoes



Retail Price (Import)	600 FCFA /kg
Retail Price (local)	350-450 FCFA /kg
Farm Gate Price (late season)	320-325 FCFA /kg
Farm Gate Price (early season)	150-180 FCFA /kg

Potatoes produced by small scale farmers in Senegal make their way to the markets around the country by a fairly developed system that involves traders, agents, wholesalers and finally retailers. Marketing platforms are in the initial stages of planning. This system stretches across the country making potatoes produced in the Niayes available in the local rural markets and urban centres.

Imported potatoes, have a shorter, more direct route with fewer actors involved in the chain. They are sold by importers to wholesalers, who then sell to retailers and the HoReCa sector. Finally, baby potatoes, tend to be sold on the local market near farms.

3.5.1 Traders (Bana Bana’s) & Coxeurs

As with many African value chains traders play a critical role in getting produce from the fields to the markets. They purchase potatoes field-side, or at established marketing platforms. They then transport these to wholesalers in markets where the potatoes will be sold. These traders are generally well informed and help to connect the consumer and producer markets. Some large

⁴ These get used in different ratios, so the application rates would need to be taken in to consideration to calculate the costs per hectare



producers sometimes act as collectors themselves collecting potatoes from smaller producers and marketing these. As a result, Bana Banas focus on either rural or urban markets.

Commissioned agents often play an important part in marketing produce for farmers. These are known as coxeurs. In some cases, coxeurs are simply farmers who are connected and skilled enough for the job. In return they receive a fee per bag of produce sold.

On the market end, they are also sometimes tasked with sourcing product for a specific market. This could mean that the Bana-Bana will work with coxeurs in the Niayes to purchase his stock. And then he could travel to Dakar where he will work with a coxeur to sell his stock to wholesalers.

3.5.2 Marketing Platforms

Marketing platforms were developed in the onion sector to facilitate the seamless marketing of that product. This is a new idea for the less organised potato sector. In the case of onions, a variety of charges are levied to the farmers for being able to use the marketing platform. This will ostensibly be the model for potatoes when this idea is fully realised. At the moment some collection points exist with the idea to either expand on these or to combine onion and potato marketing platforms. As a result, a model of the costs levied at the onion marketing platforms is supplied below.

Figure 11 Illustrative Fee Based on the Onion Marketing Platform Fees In Poutou

Fees And Taxes Levied At Onion Marketing Platforms					
	Taxes	Handling	Weighing	Sorting	Coxeur
Fee per 50kg bag	50 FCFA	50 FCFA	50 FCFA	200 FCFA	100 FCFA

3.5.3 Importers

Importers in Senegal tend to import a variety of products at different times of the year. This means that one importer could be involved in the import of potatoes and onions. Though there are more than 50 importers, 10 are responsible for 80% of imports. This is especially true as the import of potatoes is well controlled like onions. Each year the Market Regulation Agency (ARM) works with the sector to determine the trade window as well as the volumes of potatoes that will be allowed in to the country, and assigns quotas to importers. 50% of the quota is determined by the previous year's market share in the imported potato market. 50% is based on the volume of local potatoes purchased in the previous year. This in turn means that importers are forced to participate in the local market. They do this by working closely with large wholesalers of onions and potatoes. This is also the route for onions from industrial producers, enabling the importers to reach their local volumes numbers without too much effort. Importers tend to market imported potatoes to wholesalers and semi-wholesalers in Dakar. These then pack the onions in to suitable bag sizes before selling these on to retailers.

3.6 Indirect Actors in the Potato Supply Chain

The potatoes value chain is fairly organized in Senegal. As a result, a variety of indirect actors play (potentially) in its operations.

3.6.1 Market Regulation

Various measures have been introduced to encourage the development of local production. Firstly, **tariffs of 42%** were introduced on imported potatoes. Secondly, a **temporary annual import ban** was put in place, allowing potatoes to be imported in a window when local producers are not able to supply the market. Typically, this is from July to January, although the exact timing is determined by a steering committee of actors in the value chain as well as regulatory authorities. To prevent importers from ordering large surplus volumes during the import window, **a quota system** was introduced. Finally, ARM consults with various actors in the chain to set **recommended selling prices**- farm gate and in Dakar. However, as these are only recommended prices, actual prices vary a fair deal. In reality producers typically receive lower prices at peak production period, while consumers pay higher ones.

3.6.2 Professional Organisations

Professional organisations are a common feature of the agricultural sector. Various cooperative unions, producer federations, groups and associations all work in some way to organise farmers at the local, regional and national level.

In the Niayes the **Association of Maraîchères des Niayes Unions (AUMN)**, from 2001) was created to support quality management, access to water and professionalization in their representation. It is very active in organizing the producers in the Niayes for a variety of crops. In the specific case of potatoes, they play an important role in providing imported potato seed.

At a local level, a few active producer associations work in the potato sector (amongst other crops). These are Book Ligueye Notto Gouye in Diamma; APMK Association des Producteurs Maraîchers de Kayar; GIE des Producteurs Maraîchers de Kayar; Association des Producteurs Maraîchers de Fass Boye.

3.6.3 Banks and Microfinance Organisations

In theory, potato farmers are able to access financing through the Banque Agricole. In reality most farmers who are not able to self-finance, get financing from personal networks. Where they are interested in pursuing financing from the banking system then tend to turn to micro-finance organisations. PAMECAS, the Union Financiers Mutualiste, LBA, UIMCEC, Credit Mutuel du Senegal, are some of the MFI's extending loan products to small scale farmers.

These institutions offer unsecured lending, at 16% interest per year with a payback period of 3 years for investments in equipment or working capital for inputs. The growing popularity of solar irrigation- and the fact that it makes good business sense- means that this has become an important area of activity for these MFI's. These MFI's tend to work with the input and equipment suppliers, who provide interest free loans to the MFI's. They in turn conduct an assessment of the producers' credit needs, provide advice and conduct an assessment of the general credit worthiness of the recipients.

The MFI's are also able to access funding from the Priority Investment Guarantee Fund (FONGIP).

3.6.4 Input Supplier Financing

Input and equipment suppliers have been playing an increasingly more important role in financing of inputs and of equipment. As mentioned earlier, Senegindia provides pre-financing of inputs for farmers in their "contract system". A novel approach from solar irrigation suppliers involves them



providing interest free loans to MFI's. They then extend credit to producers at 16% interest rates. This is an important driver of recent growth in access to mechanised irrigation equipment.

3.6.5 Agricultural Insurance in Senegal

Agricultural insurance been developed fairly recently in Senegal. The National Agricultural Insurance Company of Senegal offers a variety of insurance products in all agricultural sectors with the exception of livestock and fishing. Risks of crop failure due to flooding or (index insurance), to damage caused by birds, wildlife, etc. are some areas that are covered.

There are no specific products developed for potato producers and in general they're unaware of products that might be available.

3.7 The Knowledge Sector

Knowledge and skills development are two important supporting activities in the agricultural sector. A sound structure would have a good combination of proactive research and development, which is then enriched and disseminated to professional education, vocational training and extension services.

3.7.1 Research and Development & Professional Skills Development

Agricultural research and development falls under the remit of the Senegal Institute of Agricultural Research (ISRA). It falls under the Ministry of Agriculture and Rural Equipment's (MAER) but operates as an autonomous unit. The Institute of Food Technology and the Universities of Dakar, Thiès, Saint Louis and Ziguinchor all contribute to knowledge development in the sector. Some private companies are also involved in research. For example, Tropicasem conducts applied research. This involves testing whether the available seed performs in the Senegalese environment.

The local knowledge developers listed above also work alongside international actors. For example, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) of the CGIAR and advanced research institutes and universities in Europe (e.g., the Institute for Research on Development, France) and North America (e.g., University of Florida). How active they are in potatoes would need to be explored further.

3.7.2 Extension Services

Typically, extension serviced in the developing world are delivered by a combination of the state, the private sector input and equipment suppliers and NGOs or donor partners. A framework for extension services exists in Senegal. But activity is focussed on the core food crops such as grains and groundnuts and to some extent onions. Potatoes have attracted far less support from the state.

From the private sector, there's very little activity in providing knowledge around pesticides, seed, fertilisers etc. This is partly because of the structure of the system and partly because of low skills development. To better understand the framework provided by the state a short explanation is provided below.

Extension Services are designed to be coordinated and developed by **ANCAR**. This state funded agency has extension staff in each of Senegal's 45 districts and 190 counties. However, a chronic shortage of funds means that there's been a high vacancy rate in the organisation since 2017.



To support ANCAR, Special Regional Development Agencies (**SRDR's**) were established by the government. They operate in particular zones and on particular theme. For example, the Senegal River Development Agency (**SAED**) was created in in the Senegal River Valley to support the development of irrigated agriculture there. The Agency's advisory service employs 85 field extension staff equipped with motorbikes and 12 supervisors, who have four-wheel drive vehicles. Extension activities include participatory diagnosis, needs assessment, implementing activities and monitoring and evaluation. SAED receives funding from the government and is currently managing seven donor- financed projects funded by the African Development Bank, the French Development Agency, the Japanese International Cooperation Agency, the Korea International Cooperation Agency, the Kuwait Fund, the Saudi Fund for Development and the World Bank. Another relevant agency is **ANIDA**. Founded in 2006, the National Agency for Agricultural Employment and Development is tasked with creating large, modern farms in "community agricultural domains," primarily to serve as employment opportunities for rural youth and to promote agricultural development. Twelve such domains are in operation and include over 100 farms. ANIDA employs 70 extension agents, who are supervised by 12 extension managers. Donors include the African Development Bank and the governments of Senegal, Spain and Brazil. In addition to extension services, these organizations provide a range of support including infrastructural development and supply of inputs.

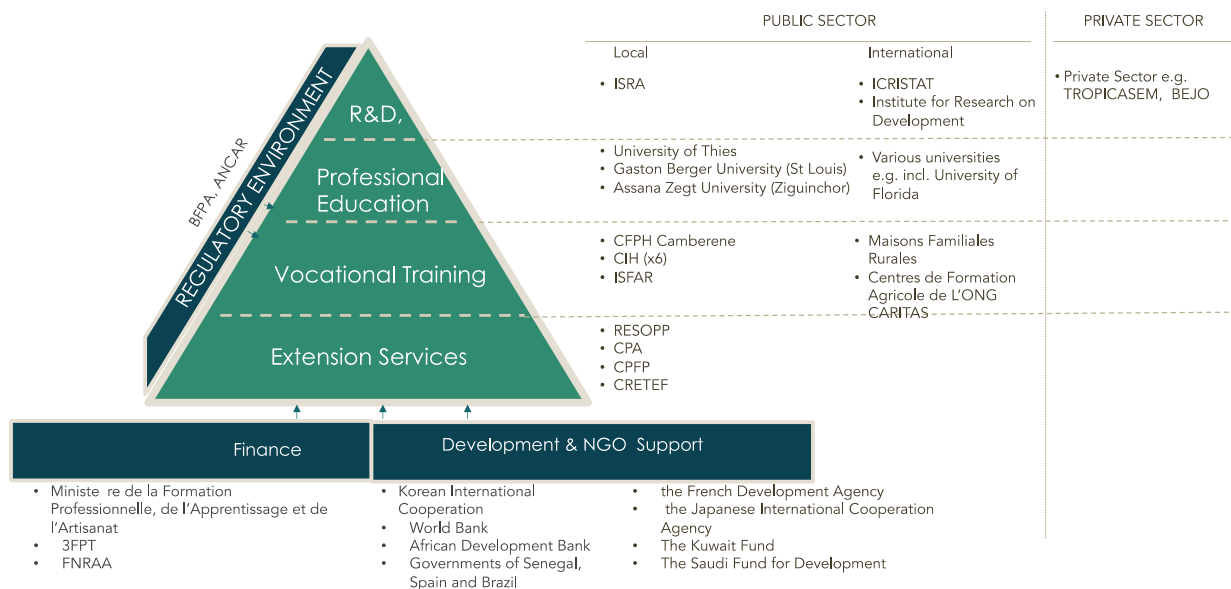
Some professional and cooperative organisations provide training for their members. For example, RESOPP, a federation of farmer cooperatives, offers training services to its member cooperatives as well as non-members. They have training facilities in 8 out of the 15 regions of Senegal.

Centre Polyvalents de Formation des Producteurs (**CPFP**) & the Centres Régionaux de Formation Technique et Professionnelle, (**CRETEF**) provide training on agricultural techniques and innovative techniques for farming amongst other topics. These are targeted at producers.

Specially for potatoes, the biggest gains have been made thanks to support from PADEN. The potato program focussed specifically on extending the use of irrigation and improvements to irrigation techniques. This is credited with helping larger more advanced farms from making the increase in yields from 15 tons per ha to 30 tons per ha (or something in between).

The state department for agricultural research ISRA, provides some guidance around planting of potatoes in the Niayes. And additional support is provided from seed suppliers. However, this is far less than is required of a crop that benefits from technology and precision techniques.

Figure 12 Overview of Knowledge and Skills Development Actors in Senegal



3.7.3 Finance (Agricultural Knowledge Sector)

Financing of skills development and research and development related to agriculture is provided by the National Agro-Food Research Fund of Senegal. This is a government agency established in 2004 that mostly funds research but has recently started funding dissemination of knowledge. The National Fund for Agro-Sylvo Pastoral Development (FNDASP) provides funding to support for the dissemination and large-scale adoption of technologies. They also fund projects that will expand the availability of certified seeds for priority sectors by promoting sustainable seed systems. Finally, bilateral and unilateral donor agencies such as the World Bank provide financing within specific programs e.g. The World banks funded West African productivity program.

3.7.4 Advisory and Training Policy Environment

The Bureau for Professional Agricultural Training (**BPPA**) is a service department of the ministry of Agriculture. They are responsible for coordinating agricultural and rural training policy in Senegal. Their ambition is to provide education to especially the rural population of Senegal by supporting and coordinating initiatives that improve agricultural education.

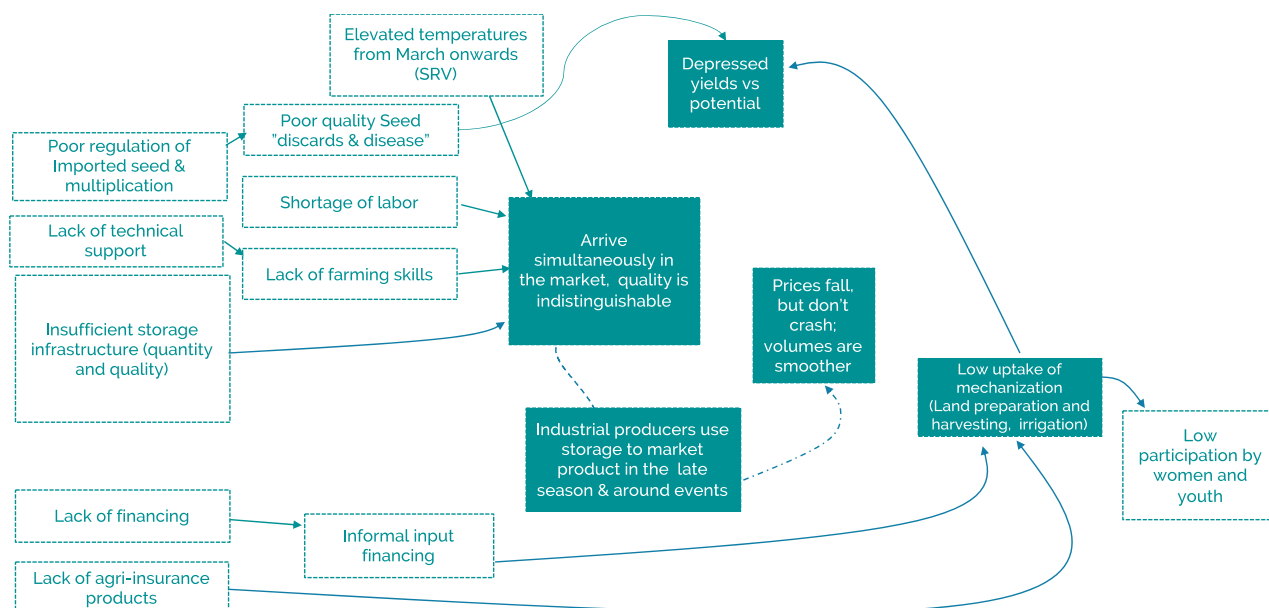
ANCAR is parastatal that was formed in 1997 and given the role of providing advisory services throughout the country. ANCAR's mission is to provide a national system of rural and agricultural advisory services through improving advisory service delivery, harmonizing advisory methods, and facilitating a network of public and private advisory services. While the hope was that state funding would diminish over time, in reality it remains largely public sector funded organisation. In addition to providing advisory services, they also are to link farmers to the providers of inputs, credit, marketing and processing services.

4 Issues and Opportunities Along the Value Chain

Figure 51 reviews the most important issues along the value chain. These are discussed in the following sections.

Figure 13: Overview of the Main Issues and its Effects on the Value Chain





4.1 Unreliable Seed Arrival, Quality & Disease

There's a defined policy framework for seed imports and multiplication in Senegal. Producers are allowed to import seed. However, DISEM provides authorization for seed multiplication after an importer has demonstrated that the variety meets acceptable standards. Typically, these include fairly basic demonstration plots rather than more thorough research into the suitability of the seed to withstand specific local conditions such as increasing salinity. Also, while the Directorate of Vegetable Protection (DPV) ensures that the imported seed is healthy i.e., free from rot; it doesn't ensure that the seed is qualitatively good i.e., has good germination rates.

Thereafter, the framework allows for seed multiplication to be controlled. Yet again, small budgets and low capacity prevent DISEM from providing any real regulatory control over the sector. They tend to delegate checks to the regional authorities, who lack resources to conduct field checks.

Improvements to seed and ongoing research and development are important components to a dynamic, responsive seed system. Yet, uncertain protection of the seed rights in Senegal has resulted in established international seed producers abandoning local seed programs and other avoiding supplying potato seed to this country.

A short production season means that for many farmers the planting window is relatively small. However, potato seed often doesn't arrive on time. This could be driven by delays in the harvesting of seed in the EU, which is typically done in July or August, and shipping delays. A second issue is the quality of the seed. Local producers view the seed being sent as "discards" from European production. In reality potato seed prices, the quality of that seed and patent protections are all interconnected.

First newly developed certified seed is more costly than older seed varieties. In general, the benefits of new research and development is costed in to the sales prices. Secondly, the developers of that seed or tuber are very protective of their costly intellectual property. However, once the seed is used it is difficult to stop people from multiplying it without paying royalties (breeder rights).

Breeders of new varieties tend to deal with countries that have poor protection of breeders' rights in four different ways:

- They don't sell seed potato at all to these markets.
- They only sell older varieties.
- They sell seed at a much higher price, to compensate for illegal multiplication. They price the loss of royalties into the sales price.
- They only sell seed that cannot be multiplied further without degenerating.

Countries with more robust protections for seed patents, are able to access more recently developed seed, and even establish strategic partnerships with breeders for local multiplication.

Finally, imported potato seed in some instances have introduced diseases to local fields. This is supposed to be "weeded out" by the regulatory authorities during the import permit process.

As a result, it would seem that there's a good case for local commercial potato seed production. This seems technically possible from an agro-ecological perspective. Potato seed requires temperatures below 20°C and humidity below 30%-40%. It does however require tight control over diseases, especially where this is tuber production, a good use of new technology and a strong regulatory environment. It also requires strong laboratory services to be able to track and diagnose diseases as they develop so that remedial action can swiftly be taken.

The key challenge however is the storage of the seed over a 9 month period. A variety is needed that can be stored long, and the production and storage cost have to be compared to the cost of importing seed. However, if the reliability of the delivery is a problem, local production could solve this.

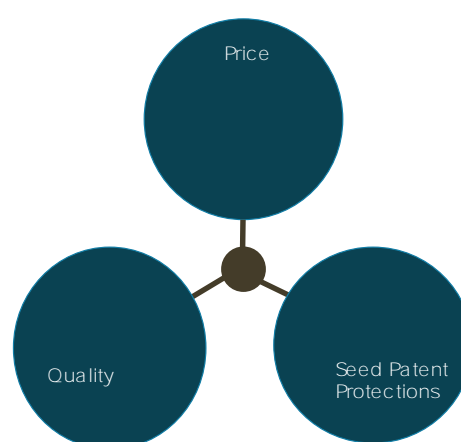
4.1.1 Under-Resourced Plant Protection Agencies (DPV & DISEM)

The agencies responsible for the quality of seed in Senegal are hampered by a lack of resources. They have too few people and too small a budget to ensure that reliable seed quality control is possible. As a result, they lack quality laboratory infrastructure to be able to carry out rigorous testing. In the case of local seed multiplication- which occurs especially for other cereal crops- they lack the infrastructure for a track and trace system. Tackling these issues would provide some defence against deteriorating seed quality and the import and distribution of poor quality or fake seed.

4.1.2 Poor Farming Practices

At harvest time 80 working day equivalents are typically required to harvest 1 ha of potatoes. Most farmers aim to get this job done quickly and in some cases find it challenging to find this labour. There's a lot of competition in this region for labour from small scale farmers of various

Figure 14 Potato Seed Price- Quality- Seed Patent Protections Dynamic



crops and industrial vegetable farms. The migrant labour used on these farms, the sourghas, are themselves under time pressure as they need to return home to prepare their own fields. Mechanisation is a helpful tool to ensure that farmers are able to harvest quickly, especially should production be expanded. In our experience a lot of potatoes are left in the field after manual harvesting; in some countries up to 30%. This is not only a financial loss but also increases disease pressure, even for farmers who rotate land.

4.2 Yield Improvements & Mechanisation Services

Small scale farmers without irrigation have been left behind in terms of yields. They achieve up to half the yields of larger more established farms. On the other hand, improved techniques, mechanisation and quality inputs have allowed Senegindia 25% higher yields. This yield gap would provide a major improvement to the livelihoods of these farmers. It will however require an expansion of mechanised irrigation, improved farming techniques and mechanised land preparation and harvesting.

Mechanisation for potato farming is important for 2 reasons:

- Potato is a precision crop, and mechanised land preparation, planting and harvesting is much more precise and leads to better yields.
- Potato is very labour intensive, and usually the amount of labour available determines how much land can be farmed.

Unlike popular belief, mechanisation usually does not lead to cost savings. But it does improve profitability and revenue through higher yields and a larger area farmed.

Large farmers currently have their own tractors and implements, but for small farmers this is not feasible. It takes about 30ha of land to make operate a tractor with implements economically.

Across Africa and much of the developing world the government has tried to develop public mechanisation services, but these have almost always failed because of bad business management. A typical public owned mechanisation services has at best only 50% of its fleet operational. A mechanisation service is a fairly complicated business that requires skilled and responsible drivers, good sales and work planning skills, and skilled mechanics doing weekly maintenance and repairs. In our experience we have seen four different private models that can work:

- The nucleus farmer model, where an emerging farmer with 10-20 ha wants to mechanise, and provides services to his/ her neighbour in his spare time in order to utilise excess capacity of the tractor.
- The owner operated service, where the owner drives the tractor while a family member goes out to sell services and plan the work simultaneously. In some countries these tractors migrate to follow the season across the country.
- A private mechanisation business with multiple tractors and implements employing drivers, mechanics and sales people and planners.
- Processors or large farmer – aggregators with outgrower schemes who service farmers in their scheme.

It would be interesting to explore these models in the Senegalese potato sector context.

4.3 The Storage Conundrum

From the perspective of the system there are real benefits to storage development. Around the world this has been a critical step to the development of a consistent supply chain. It's also critical in potatoes to being able to hold tubers over from season to season, or to developing a local potato seed (tuber) production. Potato prices at the start of the season when the bulk of the farmers harvest. Throughout the season they increase with 77% over a 4 month period.

Storage has been a hot topic in the onion and more recently for the potato chain. As a result, several efforts have been made to expand storage capacity. These projects involve different models ranging from informal community/ village level stores, improved development aid financed storage – which might have better construction and ventilation; as well as commercial, cold storage and climate-controlled models. Quality, climate-controlled storage is now available in Dakar for 27 FCFA per kg of onions or potatoes per month. A warehouse receipts system is also being developed that aims to incentivise greater use of storage.

From a technical perspective, potatoes are can be stored with low loss rates (<5%). But this does rely on storing quality potatoes suitable for storage. Getting good control of inputs and farming practices is an essential ingredient to this model working. However, given that the cost of storage is 26 FCFA per month and the average increase in the wholesale price is FCFA 41,25 per month over 4 months, the margins are not exceptional for everyone. It depends on storage losses and the cost of storage. Figure 53 provides different storage scenarios for a farmer who can choose to sell his potato to a trader at 165CFA, or put them in rented storage.

Figure 15 Profitability of Potato Storage by Farmers

Purchase		Sale		Storage duration	Gross margin	Potato quality	Storage Loss		Storage type	Storage cost	Financing cost		Profit
165	Feb	200	March	1	35	bad	10%	20	traditional	13	1,65	0,35	0%
165	Feb	250	April	2	85	bad	20%	50	traditional	26	3,30	5,7	3%
165	Feb	300	May	3	135	bad	30%	90	traditional	39	4,95	1,05	1%
165	Feb	320	June	4	155	bad	40%	128	traditional	52	6,60	-31,6	-19%
200	March	300	May	2	100	bad	20%	60	traditional	26	4,00	10	5%
165	Feb	200	March	1	35	bad	3%	7	high tech	26	1,65	0,683	0%
165	Feb	250	April	2	85	bad	7%	17	high tech	52	3,30	13,03	8%
165	Feb	300	May	3	135	bad	10%	30	high tech	78	4,95	22,05	13%
165	Feb	320	June	4	155	bad	13%	42,6667	high tech	104	6,60	1,733	1%
165	Feb	200	March	1	35	good	5%	10	traditional	13	1,65	10,35	6%
165	Feb	250	April	2	85	good	10%	25	traditional	26	3,30	30,7	19%
165	Feb	300	May	3	135	good	15%	45	traditional	39	4,95	46,05	28%
165	Feb	320	June	4	155	good	20%	64	traditional	52	6,60	32,4	20%
165	March	320	June	3	155	good	15%	48	traditional	39	4,95	63,05	38%
165	Feb	200	March	1	35	good	1%	2	high tech	26	1,65	5,35	3%
165	Feb	250	April	2	85	good	2%	5	high tech	52	3,30	24,7	15%
165	Feb	300	May	3	135	good	3%	9	high tech	78	4,95	43,05	26%
165	Feb	320	June	4	155	good	5%	16	high tech	104	6,60	28,4	17%

For our calculations we have assumed the cost of traditional storage to be half of that of high-tech storage, and the financing cost to be 1% per month.

The maximum profit to be made is 38%, for high quality potatoes stored for 3 months in a traditional storage with 15% loss. A farmer doing the same in a high-tech storage achieves only 26% because the lower loss rate does not outweigh the higher cost of storage. However, we expect poor quality potatoes in traditional storage to have too much loss to make storage profitable while putting poor quality potatoes in expensive storage is also not that profitable. Though there does seem to be a case for storage of better-quality potatoes, one has to keep in mind that there are also risks involved. Losses can be higher, prices can come down, product can be stolen etc.

4.4 Regional and EU Export For Potatoes

There may be a small opportunity to export potatoes to the EU in February and March as a premium new season/ fresh potato. However, prices in Senegal are much more attractive than those in the bulk-market in the EU. Prices in February can fluctuate between 30 and 250euro per ton, depending on how good the yields were. This is much lower than the 180CFA (250euro) farmers can receive farm gate in Senegal.

There is most certainly an opportunity for regional potatoes as consumption is increasing but the number of areas where potatoes can be grown in West Africa is limited. Senegal has a much higher yield per ton and should be competitive with other growers. However, the opportunity will be limited to countries import bans or import duties for EU potatoes which are cheaper than current Senegalese prices. However, as the industry grows and domestic prices and margins come down to more realistic levels, it may be attractive to sell in neighbouring countries.

4.5 Salinisation & Water Use

Irrigation is an essential component of potato production in the Niayes. Over time these irrigated and fertilised soils create seepage of minerals into the precious groundwater. In the hot summer months, some farmers leave their land fallow, preferring to wait for cooler temperatures. But this draws water up from the groundwater table and further increases salinity of the soil. Even with clever selection of seed, there's a limit to what is possible for successful cultivation in saline environments.

This issue is especially critical in the Niayes region, where the underground water reserves being used for agricultural purposes feed the city of Dakar, or where city water is being used to irrigate crops.

This scarce resource requires better management. Firstly, to ensure that farms use only the least amount of water possible for successful cultivation. Secondly, some planning is needed for summer crops to keep the land in use. Finally, a longer-term planning is required to ensure that water resources are used sensibly. Without well thought through water and land management continued salinisation can be expected.

4.6 Access to Finance

Large banks in general focus their services on large business. This is driven both by high administration fees for small loan sizes as well as a weak service footprint in areas traditionally suited to small scale farming.



Micro-finance institutions appear to be far more active in the potato chain. They offer products that are better suited for providing for the smaller loans needed to finance irrigation equipment as well as working capital for inputs. The Senegalese are however “bank-shy” when it comes to credit. Generally, they prefer to rely on personal networks and self-financing to fund their activities. This also helps them to avoid the unanticipated risks related to weather. The low availability and uptake of Agri-insurance is another issue that holds them back from taking out credit. While the products are theoretically available in Senegal, few of the financial institutions offer any insurance beyond coverage on the principal loan amounts in the case of death.

Finally, there is some case for improving financial literacy amongst these farmers, especially as it relates to growing onions as a business. Many were unable to provide clear answers around cost of production, marketing costs, the benefits of accessing working capital etc.

Agri-insurance is theoretically available to farmers. But most financial institutions don't offer much insurance beyond life insurance to cover loans.

4.7 Fertiliser

Imported fertilisers in theory should deliver consistent product to the farming community. However, there have been complaints around cheating that go back to the early 90s. To combat this issue a national fertiliser committee was created. But a lack of resources means that they rarely carry out checks on fertiliser quality. Chemical compositions thus sometimes differ from that on the bag.

The imported fertilisers generally have very standardised formulations that haven't been adapted to local growing conditions, nor to potato specifically. In addition, soil conditions are not tested and so farmers rely on generic advice around fertiliser application. This seems a fairly blunt approach for such an important crop.

International investors, who have the ability to optimise these formulations, face local market conditions that discourage investments in larger more targeted fertiliser development, marketing and sales. Firstly, they face competition from the firms who are allowed to distribute fertiliser in the government subsidy program. Secondly, the subsidy program sets unrealistic price expectations for fertiliser in general. Thirdly, farmers rely sometimes on fertilisers from poultry or peanut shells. There are some concerns that this might need better management to avoid the unintentional spread of diseases.

4.8 Industrial Producer Issues and Opportunities

By far the biggest threat to the industrial production of potatoes is a lack of sustainable farming practices. Fields are not rotated meaning that a potato field is planted with potatoes year after year. A short respite might be given over the summer months when the fields are left fallow. However, during this period high summer temperatures mean that the soil bakes, reducing the organic matter in the soil. Green manuring and rotation would be helpful in maintaining soil fertility while helping to manage disease pressure. Until now disease outbreaks have been few, speculatively because of the high summer temperatures. But issues from increasing nematodes



and cysts are emerging and this will need to be managed to ensure the sustainability of industrial production in Senegal.

Irrigation from the lake requires that water be pumped to the farm. This makes the **cost of fuel linked to irrigation** a sizeable contributor to the cost of production. Not being able to rely on electricity also increases the costs of refrigerated storage. This is especially critical in seed potato storage from one season to the next.

Skills issues on these farms are another common issue. Staff might have relevant qualifications, but often they lack practical skills and experience to be productive. As a result, these farms must provide significant on the job training before staff can become productive. Specialist skills are currently being sourced from India and South Africa rather than from the local universities and training colleges.

Finally, Senegindia seems to have a reputation issue. Local producers feel that this business specifically is responsible for unfair competition in the potato market. Also, in 2016 an issue arose around land rights related to an expansion of the Senegindia farm. These are all potential areas of concern, especially as this farm is such a major producer in the country.

Land rights are a specific issue in attracting more investment into the sector. Large industrial producers are able to able large tracts of land, sometimes thousands of hectares. As these large farms develop, they attract labour from far afield. Over time these new settlers have a need for land. These pressures intensify existing frictions where it comes to land. The land rights system in Senegal is known to be fuzzy and complex. And for women and youth, this often means that they are marginalized when it comes to accessing land. These tensions erupted in 2016 leading to a land grab near the Senegindia development. Naturally all industrial investors across the open field crops are aware of the potential for friction with local communities. This is a potential hurdle when it comes to attracting further investment in the chain.

It will become increasingly important that the case for industrial development is made clearer to indigenous communities & wherever possible that community development is built into the project. It would be particularly helpful if some thought is given to how agricultural industrial investors can play a bigger role in dissemination of production techniques and support or the agricultural services that many small-scale famers requires if they are to increase the scale of their commercial investments. At present industrial producers play a small role in professional associations in Senegal. But this poses a real risk in that they remain separate from the sector. This will need some attention for the sustainability of this type of investments.

4.9 Processing Issues and Opportunities

Processing of potatoes in Senegal is currently limited to small scale crisp production. There is some interest in some producers to expand in to potato crisp production for children. However, snacking in Senegal is relatively low, thereby limiting the market. Nevertheless, the high transport cost of crisps provide a natural barrier against imports. Transporting crisps is mostly transporting air, with only 6tons of crisps that can fit in a container versus 23 tons of frozen chips. Furthermore, automatic processing lines are available from 100kg per hour, and become economic to operate at about 250kg/ hour. It might however require clever marketing strategies such as focussing on the Hotel and airline sector.



Frozen chips however as well as industrial starch is a low margin high volume business that is impossible to develop in Senegal. The minimum scale is 5 tons per hour, and Belgium and the Netherlands have more than a dozen factories capable of processing more than 60 tons per hour.

Another potential innovation opportunity in processing would be to explore the production of fresh cut chips, potentially blanched/ pre-fried delivered daily to the HoReCa. This has been a growing sector in Nairobi. It can be started at a very small scale with manual production. The advantage for fast food, restaurants and hotels is that they save space as the production of chips requires a lot of staff and space. Furthermore, fresh cut chips have a much better flavour than frozen chips.

4.10 Marketing and Distribution

The Market Regulation Agency has been instrumental in organising with Senegindia to ensure that their potatoes reach the market towards the end of the small scaler marketing season. This has helped to manage pricing in the market, so that farmers face a normal level of variation in prices that you would see in just about every vegetable chain around the world. In some years the system isn't perfectly managed, and this creates some tensions between Senegindia and producers. This is especially true as Senegindia is often allowed to sell their potatoes around festivities, which might coincide with small scaler marketing seasons.

The overwhelming volume of potatoes are sold at markets. These reach retailers via a finely tuned system of traders, wholesalers and retailers. Packaging for potatoes has become more available in recent years. Yet many still re-use packaging, which in some cases are damaged and torn.

Finally, the potatoes must be transported from the Niayes to markets around the country. While significant progress has been made in improving the quality of road networks in the primary road network an along the coastal areas, there is still much more that needs to be done. This is especially true when it comes to accessing rural areas. These logistics issues likewise affect the costs of distribution of potatoes, especially as production is limited to a small region.

4.11 Dynamic Knowledge Development

As with many other agricultural value chains in Senegal, extension services are fairly limited. Also, development of new knowledge is weak. Little research and development is being proactively carried out on agricultural techniques, seed optimisation, sustainable farming etc. This is particularly concerning in view of the ecological sensitivity of the production environment that is exposed to climate change and salination. Potatoes are also particularly vulnerable to poor farming practices. Diseases can easily be introduced, or nematode infestation set in if there's poor crop rotation. This will require some attention to ensure sustainable expansion of the sector.

Producers could benefit from proactive knowledge development. How can farmers adjust to their farming practices to be less vulnerable? How can resources be best allocated to ensure sustainable agriculture? This requires proactive work to identify appropriate seed for the Senegalese context and then to ensure that farming techniques are optimised for this country. contexts.



In addition, more could be done to ensure that the sector is more responsive to weather and climate change. On the most basic level this means ensuring that farmers have better access to information. This includes weather forecasts and faster agricultural advice, to meet changing conditions. Some local programs, such as STARS, have been experimenting with digital tools to share up-to-date information around markets and weather. Yet, more needs to be done to develop knowledge around how to best plan for and respond to these changing market and environmental conditions.

5 Environmental Sustainability (Circular Economy)

Potato production is possible only in the Niayes and a few areas in the Senegal River Valley. The favourable growing conditions in winter mean that there's increasing competition for resources in this area, particularly for water. This is drawn from underground wells and boreholes. Sometimes these need to be drilled more than 100m below the surface. This poses a real threat to the communities who rely on this groundwater for drinking water. This includes Dakar, which draws water from this underground aquifer.

At a systemic level more attention needs to be paid to land management and to planning of areas that will be used for production. Some deep introspection is required around the development plan for the Niayes. What crops should be zoned for this region, if any at all? Which productive activities in the Niayes should be redirected to other parts of the country? Should potato production- especially of industrial producers- be regulated so that expansion is directed north towards the lake? Or should small scalars be encouraged to intensify production nearer the coast?

A second related issue is **declining soil health**. Continued Irrigation, heavy application of fertilizers and pesticides and leaving lands fallow in the hot summer months all affect the salinity of the soil, organic matter, micro-organisms and the groundwater. While this affects small scalars to a certain extent, traditional crop calendars and smaller scale of production means that they raise a smaller threat. On the other end of the spectrum growing industrial production requires that some efforts be made to ensuring that these producers grow while incorporating more sustainable farming practices that protect soil health.

6 Socio-Economic Development (food security, employment, women and youth)

6.1 Livelihoods

Potatoes offer a valuable opportunity to improve livelihoods. Potato production is a lot more profitable than onion production. The gross margin per kg in real terms is 5 times higher, while the yield per ha is comparable. This means that the profit per ha is 5 times as high: 2,5 million CFA for a potato farmer with 20 tons per ha versus 500,000 FCFA for an onion farmer. This is a huge difference for farmers who only have a limited amount of land available. Figure 54 provides an overview.

Figure 16 Comparison of Costs and Revenue for Potatoes Vs Onions in the Niayes

	Onions	Potatoes
Yields	15-25 tons per ha	15-25 tons per ha

Average Farm Gate Price per kg	125 FCFA per kg	250 FCFA per kg
Gross Margin	20%	50%
	25 FCFA per kg	125 per kg
*Based on existing cooperatives in the Niayes		
**Based on average market prices for onions; sales price for potatoes based on contract prices with Senegindia		

The profitability of potato farming seems almost too good to be true. However, it is consistent with what we have seen in other African countries such as Kenya, Cameroon and Nigeria. Potato farming is a high risk- high reward crop. It requires high investments in inputs, particularly seed, and labour. It is also a diseases prone precision crop, that can easily be wiped out by disease. In our experience the break-even point is usually around 5 tons per ha, which tends to be the average yield of small scale farmers, going up to 10 – 15 tons for emerging commercial farmers. Every ton of yield above this 5 tons makes the business a lot more profitable quickly. From the perspective of employment, the effort required for land preparation and harvesting of potatoes means that far more labour is required overall. Figure 55 makes a comparison between onions and potatoes.

Figure 17 Comparison of labour utilisation for potato and onion production in the Niayes

Labour utilisation comparison- Onions vs Potatoes (Niayes), per ha; 2019		
	Onions	Potatoes
Land preparation	100 000 FCFA	200 000 FCFA
Ongoing care	3 sourghas x 4 months = 360 labour days	3 sourghas x 4 months= 360 labour days
Harvesting and sorting	80 labourers x 1 day= 80 labourer days (160 000 FCFA)	500 x 225= (112 500 FCFA)

Falling prices in the first half of the season and the tendency to push risk upstream towards farmers has already been mentioned as a key issue. A review of the drivers of quality issues in the potato chain also reveals that they produce these with relatively little technical, or financial support. Yet farmer's face a variety of additional pressures. Unreliable inputs, climate change, low development of agricultural or financing products and growing production from industrial highly competitive producers all raise risks to their livelihoods.

6.2 Food security

Food security- and developing some degree of self-sufficiency- is a particularly pressing theme in Senegal. Potatoes have the potential to contribute significantly to achieving these ambitions.

Firstly, few countries in West Africa are able to grow potatoes on any real scale. Only 4 countries in the ECOWAS region produce potatoes on any real commercial scale. But, Senegal, thanks to the unique conditions in the Niayes, absorbs 1/3 of all regional potato seed imports. This makes it a very important producer.

Yet there is space to grow. If the countries in this region follow global patterns, we can expect that demand for potatoes will increase. As a result, there's a unique opportunity for Senegal to position

itself ahead of this curve. To satisfy a growing appetite for potatoes each available inch of land for potatoes in the Niayes and along lac du Guerrier will need to be utilised to its fullest potential. This will require some intervention to increase yields beyond the current levels.

Figure 18 Potato Seed Importing Countries in ECOWAS

	Imports Seed Potatoes by countries in ECOWAS (2019, tons)
Senegal	4200
Mali	3300
Nigeria	1500
Guinea	1000
Other	1500
Source: ITC trade Map	

6.3 Inclusive Development

The potato value chain is at present a fairly masculine enterprise. Potato production requires access to land as well as financing for relatively expensive potato seed and irrigation. It's also a very physical endeavour, which is in many respects stereotypically male. Yet, the high revenue per ha suggest that this would be a particularly good area where women and youth could prosper. In other African countries there tend to be more female farmers involved in potato growing.

6.3.1 Women and Intensive cultivation of precision crops

Experience in East Africa suggests that women have particularly good fit with potatoes. Profitable potato farming can be done on relatively small plots of land. This is relatively more accessible than that required for more extensive crops. A second advantage is that good agricultural practices and greater precision in farming- typical of female driven farming enterprises- deliver returns. Successful cultivation can create a virtuous cycle where high revenues enable greater investment in mechanisation, which increases precision, that increases revenues and so on.

6.3.2 Women and Marketing

Women are highly involved in the marketing of vegetables, which includes potatoes. Expanding production and bring quality produce to market increases their ability to earn a good living, reduces waste from poor farming practices, sorting or handling.

6.3.3 Industrial packhouses

Women tend to be over-represented in the more detail-oriented activities in packhouses. This bodes well for their ability to find employment. This is reflected in the employment statistics shared by industrial vegetable growers. At Grand Domaine du Senegal (GDS) 22% of their staff is female. Van Oers, employs more than 4000 women during the harvest period. Furthermore, this is an area where women are generally not in competition with men. Industrial production is this a meaningful way to create better inclusivity of women in the workforce.

6.3.4 Youth & Practical Horticultural and Mechanisation services:

Technical development in the potato sector will require a skilled extension service system, with trainers who are skilled and are continuously updating their skills. This has a natural fit with the

youth. This is especially true if technology is introduced to the extension services. For example, if digital tools are used to dispense advice, provide weather reports etc.

Mechanization and irrigation services are likewise services that are better suited to a more youthful investor and workers. These are new areas, that provide space for the youth to establish themselves without having to displace established actors. The technical nature of these services also asks for continued education and skills development.

Enabling women and youth to make use of these opportunities requires a number of stumbling blocks to be removed. Firstly, without knowledge and skills it's unlikely that they'll have the wherewithal to take on these opportunities. Secondly, social norms generally dictate that any savings or surpluses are used to finance activities of the men in the household, rather than those of women and youth. Developing a business requires finance. Even more so when this business relies on mechanization or irrigation equipment. Ensuring that they are aware of these opportunities and developing financial products specifically for these groups is a first step to getting them involved in this chain. Another would be ensuring that they are armed with financial literacy. Finally, by organizing them in small producer groups they are better able to access financing, technical training and can be emboldened to take on these new challenges. (IFAD, 2018).

7 Options for Interventions

7.1 SWOT Analysis

The following SWOT analysis resumes the foregoing issues:

<p>Strengths:</p> <ul style="list-style-type: none"> – Market protections (import freezes for most of the year, quotas and tariffs) – Increasing area under cultivation and yields – Good profitability of potatoes (50% for small scalers) – Investment from Industrial producers (Mbane area) – Industrial producer loaning out mechanisation equipment to emerging farmers – Privatised seed and input markets – Relatively high yields 	<p>Weaknesses:</p> <ul style="list-style-type: none"> – Unreliable seed quality (poor regulatory control, weak patent right protection, poor coordination with suppliers, disease pressure) – Distortionary effect of fertiliser subsidies on input marketing and sales – Reliance on migrant labour at harvest & labour for manual irrigation – Risk carried by farmers – Great improvement required in extension services provision from the state and private sector – Lack of agri-insurance products
<p>Opportunities:</p> <ul style="list-style-type: none"> – Mid-tier; mid quality potatoes for local markets 	<p>Threats:</p> <p>Unsustainable agricultural practices- water management, land management, soil fertility</p>

- | | |
|--|--|
| <ul style="list-style-type: none"> – Regional export opportunity in the peak production season, especially to the Ivory Coast – Space for women as employees in industrial farms (packhouses), agri-service development (mechanization, irrigation, storage) and retailing of quality, storable potatoes – Introduce mechanisation to reduce waste & improve productivity | <ul style="list-style-type: none"> – Risks from climate change, increased salination – Pressure on groundwater suppliers that feed Dakar – Fuzzy land rights environment – Reputation risks from industrial producers who are seen as being separate and unfairly competing with local producers |
|--|--|

7.2 Interventions (SDG Goals and Impact, Dutch Transfer)

The potato value chain is ripe with opportunity. Making the most of the substantial potential of the chain for expansion does however require an acknowledgment of the constraints on production- a young market that's still developing, current limitation on yields and a need to ensure that more sustainable practices are hardcode in to the expansion of the sector. As a result, it's envisioned that interventions in this chain follow 4 major directions:

1. Increasing productive potential
2. Accessing regional markets
3. Hardcoding of sustainable farming practices
4. Inclusion

Potato farmers in Senegal are achieving remarkable yields when compared to many African countries. However, there's still potential to grow. To do so, a number of issues will need to be tackled. Firstly, farmers will need to get a more reliable access to quality, disease free seed. This will require interventions in the regulatory environment as well as with seed systems design. Some work will need to be done to develop and implement as workable made to measure legislative framework that governs vegetative multiplication of tubers. This can be supported by expanding participation of quality seed providers from key EU markets. The Netherlands is a world leader in potato seed production, so it would seem sensible to match Dutch producers of seed potato with local growers of ware. This might be extended by supporting efforts to develop local potato seed multiplication. This is a technical process that requires careful attention to managing disease and seed quality. As such partnerships with Dutch knowledge institutes and commercial seed providers would seem sensible. India is another potential partner as they develop seed specifically adapted to tropical climates and higher temperatures. This would also allow for a more dynamic seed system, where technology and techniques can be transferred and continuously adapted to the local context.

The productive potential of Senegal can also be expanded by firstly encouraging further investment from industrial producers. A second possibility is to develop outgrower schemes with a lead farmer model. This would focus small scale and emerging farmers in the Niayes on potato production. Clustering farmers in this region could help to facilitate mechanisation, which is

another important activity within this intervention area. Mechanisation would allow for improved land preparation, lower waste at harvest and mechanised irrigation.

This model would be helpful in facilitating accessing regional markets- especially to the Ivory Coast which is an importer of potatoes from Europe. Some work might be needed to encourage investors to explore this idea further.

To ensure that the potato production system as whole remains sustainable there seems to be a need for ongoing **knowledge development**. Learning new techniques so that salinisation can be better managed if not reduced, that water resources are used sparingly, soil fertility is protected or improved will all be important ingredients for sustainable production. At the industrial level incorporating crop rotation is critical so ensure the long-term sustainability of potato production. The cost of getting it wrong is just too high. To build in improved sustainability, the regulatory environment around land and water management will need to be improved. Clearer guidance and potentially legislation over crop rotation, irrigation, water use and land planning, pesticide use etc are all needed to ensure that a vulnerable to salinisation and climate change is protected, while supporting the expansion of potato production.

Finally, there are opportunities to encourage more **inclusive growth** in this chain. This would be my ensuring that the barriers to women and youth participating more fully be removed. In addition, more work will need to be done to skill them for the various opportunities that **are presented in a developing potato chain**. Mechanization and irrigation service provision as well as agricultural extension services are all new areas where they can carve out a space for themselves. This will however require a focus on access to finance, services, skills development both of farmers and professional agri-skills.

7.3 Overview of Proposed Interventions

Bottlenecks And Interventions For The Input System				
Bottlenecks	#	Interventions	Fit with Dutch Knowledge, Strategic interests etc.	SDG Goals
Productivity- the Seed System: Unreliable seed quality, late arrivals and introduction of diseases.	1a	Strengthen Seed Systems Support especially capacity building for regulatory control.	****	1, 2,
	1b	Support the expansion of the private sector supply of quality potato seed (seed, fertilizer and pesticides). Ensure that technical product training for distributors is a key part of the product offer.	***	1,2,4
	1c	Explore the technical feasibility of private sector seed multiplication. Integrate required regulatory controls.	***	1,2

Productivity- enhanced farming practices Opportunities to increase farming techniques of farmers to ensure that maximum yields are delivered sustainably.	2a	Improve extension services to improve skills of farmers (farming and financial literacy). This should include contributing to curriculum development of professional training centres (agronomic skills, machine repair etc.).	**	1,2,4
	2b	Support the expansion of mechanization , irrigation services & commercial storage	*	1,2
Regional Expansion Opportunity to produce quality premium potatoes for regional markets.	3	Support the development of commercial outgrower models linked to improved quality production (incl. storage, packaging, GAP, quality inputs).	***	
Sustainability Unsustainable agricultural practices favouring salination, over-use of water, intensive cultivation in the Nlayes etc.	4	Strengthen research and development into sustainable farming techniques, water and land management, soil fertility etc.	****	1,2,12
Inclusion: There are opportunities for women and youth to participate the value chain as employees, producers and service providers especially of mechanisation services enter the value chain as growers and mechanisation service providers.	5	Support women and youth in participating mechanization and irrigation services, extension services etc. This requires a focus on access to finance and skills development.	**	1,2,5,4

Sustainable Development Goals



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