
The potato value chain in Morocco

SDG approach for sustainable food value chain development



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Preface

The world population continues to grow and much more effort and innovation is urgently needed to sustainably increase agricultural production while decreasing its' waste and negative impacts on societies and environments. This is one of the reasons why globally 17 Sustainable Development Goals (SDGs) were defined by the UN member states in 2015 setting the 2030 Agenda for Sustainable Development, which succeeded the Millennium Development Goals on 1 January 2016. These SDGs will shape national development plans until 2030 from ending poverty and hunger to responding to climate change and sustaining world's natural resources, food and agriculture. As a consequence, all countries need to make technical choices, especially political choices to fit in with an integrated vision and a national sustainable development.

In Morocco, the national government launched a new strategy for the agricultural sector in January 2020, entitled *Génération Green 2020-2030*. The strategy primarily aims to encourage agricultural activities that create jobs and income, especially for young people in rural areas. The strategy also plans to strengthen the resilience and the sustainability of the development of the agricultural sector in Morocco, as well as to improve the quality and the capacity of the sector to innovate, for example by providing subsidies for the acquisition of agricultural equipment and by reinforcing sanitary controls. The Dutch government is dedicated to support sustainable agriculture worldwide and to become a co-creating partner for other countries with knowledge development and transition towards an efficient production of food in circular processes (LNV, 2019). Therefore, the government is also interested – through its Embassy in Rabat – to contribute to the Moroccan ambition to develop the agricultural sector.

Potatoes fit in a healthy and sustainable diet as they require less water than other staple foods like wheat and rice, and yield gaps can be closed with proper plant material and technological assistance. Therefore, sustainable potato value chains in Morocco can be an example of minimizing the use of natural resources (i.e. water, phosphorus, fossil fuels) and reducing the negative effects on the environment whilst providing healthy products for local and export markets and good farmers' income.

This study, commissioned by the Netherlands Embassy and financed by the Ministry of Agriculture, Nature and Food Quality, investigates the impact of activities of potato chains as part of a regional food system on the SDGs and their underlying targets and indicators. The study also gives recommendations on how the negative impacts can be minimized and positive impacts can be further enhanced.

July, 2020



Summary

This report investigates the impact of activities in potato chains as part of a regional food system on the SDGs and their underlying targets and indicators. It provides a first scan of the potato food chains in Morocco and its current sustainability, by reviewing the options to further strengthen market and trade relations between the Netherlands and Morocco. Therefore, both Moroccan and Dutch stakeholders were interviewed in this study. For this review, the following questions were studied:

- How can the potato value chains be described?
- How are the value chains developed in Morocco at this moment and how is the estimated development within the coming years?
- Which sustainability factors are involved in different steps of the value chains (like f.e. use of water, nutrients, pesticides, energy; losses of inputs and harvest, quality, employment, equity, education etc.)?
- How can negative impacts be minimized and positive impacts be enhanced (targets)?
- Which stakeholders are involved or have to be engaged?

The study has been performed by a literature search on potato cultivation and potato value chains and by interviewing two Dutch companies trading seed potatoes in Morocco for years and three stakeholders in Morocco. Based on the literature search and the interviews, an analysis was made of the actual potato value chains encompassing Morocco and The Netherlands, its current state of development and the estimated development in the coming years. Then, we determined for each step which sustainability factors, related to the SDGs (2, 12, 13, 14, 15, 17), are involved in different steps of the value chains and their (negative or positive) impacts on society and environment. Herein, we considered two overall transition pathways: the direction of more intensive agriculture resulting in 'smart' agriculture and a pathway 'towards organic production'. Based on the analysis, challenges and risks were identified and recommendations for sustainable potato chains were outlined.

It was clear from our inventory and interviews that the main focus of the potato value chains in Morocco is at present on primary production. Most of the produced potatoes are sold to the consumer on-farm or on local markets, through retail traders, supermarkets and other intermediary parties, while processing of potatoes hardly occurs. The market price is not well regulated (open market), it varies day by day, depending on day trading and supply and demand.

The growing of potatoes strongly depends on irrigation performed either by drip or furrow, while disease pressure on potatoes in Morocco is big and increasing. Mechanization is only partly implemented in the farm management. Measures like crop rotations, adequate phytosanitary facilities, etc. are hard to implement in the farm management, because many farmers are poorly educated and often lack knowledge on technical issues. Most potatoes are consumed directly and only stored during a short period (less than 3 months), using traditional storage methods.

The Sustainable Development Goals in the Moroccan potato value chains address a multitude of issues from poverty reduction, good health to international co-operation. In many cases there are various interrelations between the SDGs. This study provides an overview of general known positive and negative aspects influencing the sustainability of the potato chains and the related SDGs. Based on the current development of the potato food chains in Morocco, the SDGs which are related to growth of consumption and seed potatoes, and to a limited extent to processing of potatoes seem most relevant.

Issues that may have the biggest impact on the sustainability of the potato chains in Morocco are:

- Increasing the income of farmers and improving their knowledge;
- Implementing the efficient use of water for irrigation;
- Reducing loss of harvest;
- Promoting an efficient and reduced use of pesticides and fertilizer to avoid pollution of groundwater.

Without outside interventions, the potato production chains will develop autonomously anyhow conform global trends. The innovations going along with this development may both improve or deteriorate the level of sustainability. The need to improve the livelihood of farmers in order to reduce poverty, to avoid hunger and to offer farmers and hired farm labourers decent working conditions will

be a driver for this development as is also the need to be competitive on the international market. In order to diminish or prevent negative effects and to stimulate positive effects on sustainability, advice can be given on how to deal with the innovations and on how choices and (political) strategies may affect the transition towards more sustainable agriculture positively. To be able to make for innovation of the potato chains, development factors are held against the sustainability bar to get insight into the opportunities and risks. From this comparison it is concluded that innovations should be accompanied by a strict legislation and need for monitoring and enforcement, and by incentives for the sector to adopt water-saving irrigation systems and renewable energy technology. Development towards high-tech innovation may need a strict policy on the enforcement of constraints to avoid the increase of the water -, energy - and carbon footprints. Development towards organic production may need the stimulation of 1. integrated production systems (f.e. potato – dairy farming) to use the opportunities for re-use of manure for nutrients, or 2. Valorization of potato processing residues. Both development pathways can perfectly coexist and be stimulated by Dutch governmental strategies.

Résumé

Le présent rapport examine l'impact des activités menées sur les chaînes de production de pommes de terre dans le cadre d'un système alimentaire régional sur les SDG et leurs cibles et indicateurs sous-jacents. Il fournit une première analyse des chaînes alimentaires de la pomme de terre au Maroc et de sa viabilité actuelle, en examinant les options pour renforcer encore les relations commerciales entre les Pays-Bas et le Maroc. Par conséquent, les parties prenantes marocaines et néerlandaises ont été interrogées dans le cadre de cette étude. Pour cette revue, les questions suivantes ont été étudiées :

- Comment décrire les chaînes de valeur de la pomme de terre ?
- Comment les chaînes de valeur sont-elles développées au Maroc en ce moment et comment le développement est-il estimé dans les années à venir ?
- Quels facteurs de durabilité interviennent dans les différentes étapes des chaînes de valeur (comme l'utilisation de l'eau, des nutriments, des pesticides, de l'énergie ; pertes d'intrants et de récolte, qualité, emploi, équité, éducation, etc.) ?
- Comment réduire au minimum les impacts négatifs et améliorer les impacts positifs (cibles) ?
- Quels intervenants sont impliqués ou doivent être engagés ?

L'étude a été réalisée par une recherche documentaire sur la culture de la pomme de terre et les chaînes de valeur de la pomme de terre et en interrogeant deux entreprises néerlandaises qui commercialisent des plants de pommes de terre au Maroc depuis des années et trois parties prenantes au Maroc. Sur la base de la recherche documentaire et des entretiens, une analyse a été faite des chaînes de valeur réelles de la pomme de terre englobant le Maroc et les Pays-Bas, de son état actuel de développement et de l'évolution estimée dans les années à venir. Ensuite, nous avons déterminé pour chaque étape quels facteurs de durabilité, liés au SDG (2, 12, 13, 14, 15, 17), sont impliqués dans différentes étapes des chaînes de valeur et leurs impacts (négatifs ou positifs) sur la société et l'environnement. Ici, nous avons envisagé deux voies de transition globales : la direction d'une agriculture plus intensive débouchant sur une agriculture "intelligente" et une voie "vers la production biologique". L'analyse a permis de cerner les défis et les risques et de formuler des recommandations pour des chaînes durables de pommes de terre.

Il ressort clairement de notre inventaire et de nos entretiens que les chaînes de valeur de la pomme de terre au Maroc sont actuellement axées sur la production primaire. La plupart des pommes de terre produites sont vendues au consommateur à la ferme ou sur les marchés locaux, par l'intermédiaire de détaillants, de supermarchés et d'autres intermédiaires, tandis que la transformation des pommes de terre n'est guère réalisée. Le prix du marché n'est pas bien réglementé (marché ouvert), il varie de jour en jour, en fonction du marché du jour et de l'offre et de la demande.

La culture des pommes de terre dépend fortement de l'irrigation par goutte à goutte ou par sillon, tandis que la pression des maladies sur les pommes de terre au Maroc est importante et croissante. La mécanisation n'est que partiellement mise en œuvre dans la gestion agricole. Des mesures telles que la rotation des cultures, des installations phytosanitaires adéquates, etc. sont difficiles à mettre en œuvre dans la gestion des exploitations, car de nombreux agriculteurs sont peu instruits et manquent souvent de connaissances sur les questions techniques. La plupart des pommes de terre sont consommées directement et stockées uniquement pendant une courte période (moins de 3 mois), en utilisant des méthodes de stockage traditionnelles.

Les objectifs de développement durable dans les chaînes de valeur marocaines de la pomme de terre traitent d'une multitude de questions allant de la réduction de la pauvreté, de la bonne santé à la coopération internationale. Dans de nombreux cas, il existe diverses interrelations entre les SDG. Cette étude donne un aperçu des aspects positifs et négatifs connus qui influent sur la durabilité des chaînes de pommes de terre et des SDG connexes. Sur la base du développement actuel des chaînes alimentaires de la pomme de terre au Maroc, les SDG qui sont liées à la croissance de la consommation et des plants de pommes de terre, et dans une mesure limitée à la transformation des pommes de terre semblent les plus pertinentes.

Les questions qui peuvent avoir le plus grand impact sur la durabilité des chaînes de production de pommes de terre au Maroc sont les suivantes :

- Augmenter les revenus des agriculteurs et améliorer leurs connaissances ;
- Mettre en œuvre une utilisation efficace de l'eau pour l'irrigation ;
- Réduire les pertes de récolte ;
- Promouvoir une utilisation efficace et réduite des pesticides et des engrais pour éviter la pollution des eaux souterraines.

Sans interventions extérieures, les chaînes de production de pommes de terre se développeront de toute façon de manière autonome en conformité avec les tendances mondiales. Les innovations qui accompagnent ce développement peuvent à la fois améliorer ou détériorer le niveau de durabilité. La nécessité d'améliorer les moyens de subsistance des agriculteurs afin de réduire la pauvreté, d'éviter la faim et d'offrir aux agriculteurs et aux travailleurs agricoles embauchés des conditions de travail décentes sera un moteur de ce développement, tout comme la nécessité d'être compétitifs sur le marché international. Afin de réduire ou de prévenir les effets négatifs et de stimuler les effets positifs sur la durabilité, des conseils peuvent être donnés sur la manière de gérer les innovations et sur la manière dont les choix et les stratégies (politiques) peuvent influencer positivement sur la transition vers une agriculture plus durable. Pour pouvoir innover les chaînes de la pomme de terre, les facteurs de développement sont opposés à la barre de la durabilité pour mieux comprendre les opportunités et les risques. Il ressort de cette comparaison que les innovations devraient s'accompagner d'une législation stricte et de la nécessité d'un suivi et d'une application, ainsi que d'incitations pour le secteur à adopter des systèmes d'irrigation économes en eau et des technologies d'énergie renouvelable. Le développement vers l'innovation de haute technologie peut nécessiter une politique stricte d'application des contraintes pour éviter l'augmentation de l'empreinte eau, énergie et carbone.

Le développement vers la production biologique peut nécessiter la stimulation de 1. Systèmes de production intégrés (p.ex. pomme de terre - élevage laitier) pour utiliser les possibilités de réutilisation du fumier pour les nutriments, ou 2. Valorisation des résidus de transformation des pommes de terre. Les deux voies de développement peuvent parfaitement coexister et être stimulées par les stratégies gouvernementales néerlandaises.



1 Introduction

1.1 Background of the research

In 2015 the UN Member States adopted the Action plan '*Transforming our world: the 2030 Agenda for Sustainable Development*' to address the global challenges including those related to poverty, inequality, climate change, environmental degradation, peace and justice. The Action Plan contains 17 sustainable development goals. Well-developed integrated food value chains contribute to a variety of Sustainable development Goals (SDGs), in particular SDG 2 ('zero hunger') and 12 ('responsible production and consumption') and indirectly SDG 13 ('climate action'), 14 ('life below water'), 15 ('life on land') and 17 ('partnerships for the goals'). Potatoes fit in a healthy and sustainable diet as they require less water than other staple foods like wheat and rice (Mekkonen et al., 2011), and yield gaps can be closed with proper plant material and technological assistance. Therefore, sustainable potato products value chains in Morocco can be an example of minimizing the use of natural resources and reducing pressure on the environment, while also providing healthy products for local and export markets and good farmers' income. So, this report provides a first scan of the potato food chains in Morocco and their current sustainability.

The research was undertaken on behalf of the Dutch Embassy in Morocco. As part of its task, the Dutch embassy in Morocco is reviewing the options to further strengthen market and trade relations between the Netherlands and Morocco. At present, Dutch companies such as Agrico and HZPC are already exporting seed potatoes to Morocco. To ensure that investments of the Dutch government in the agricultural sector are contributing to sustainable agriculture, projects should consider their contribution to reaching the SDG goals. However, in order to better understand the current status of the potato food chains, the embassy has requested Wageningen (University &) Research to undertake an assessment of the potato value chains in Morocco.

Morocco has a good trade relationship with the Netherlands for years, and many Dutch enterprises are doing business successfully in Morocco for many years. So, a lot of experience has already been built up in the design and improvement of Moroccan agriculture in both countries. Therefore, both Moroccan and Dutch stakeholders were interviewed in this study.

1.2 The new strategy for agriculture in Morocco: Génération Green 2020-2030

In January 2020, the Moroccan government launched a new strategy for the agricultural sector (*Génération Green 2020-2030*), aiming at the encouragement of agricultural activities to strengthen the resilience and the sustainability of the agricultural sector and livelihoods in rural areas in Morocco, as well as to improve the quality and the capacity of the sector to innovate. The following information was derived from AgriMaroc (2020) and the Ministry of Agriculture, Fisheries, Rural Development, Water and Forestry of Morocco (2020 and interview).

The strategy primarily aims to encourage agricultural activities that create jobs and income, especially for young people in rural areas. The vision of the strategy is to foster the growth of a societal middle-class in the agricultural sector, that could function as a lever for socio-economic development in rural areas, following the example of the middle-class in urban areas. The strategy builds on achievements of the 'Plan Maroc Vert', which was the preceding strategy for the agricultural sector in Morocco since 2008, through the adoption of a new perspective on the agricultural sector, a new mode of governance, and by making available modern equipment and facilities to the sector.

The new strategy *Génération Green 2020-2030* is based on two main principles: the development of human resources through the emergence of a new generation of an agricultural middle-class (350.000

to 400.000 households) and the rise of a new generation of young entrepreneurs in the agricultural sector, through the mobilization and valorization of a billion of hectares of common agricultural land and the creation of 350.000 jobs for young people. The new middle-class population and the young farmers will also be enabled to make use of new forms of agricultural organizations and to benefit from support measures to increase their skills.

In order to achieve these aims, the strategy plans to consolidate agricultural production chains with the aim to double the export of agricultural products (involving 50-60 billions of DH) and the agricultural GDP (by 200-250 billions of DH) by 2030. Also envisaged is the improvement of the distribution network through the modernization of 12 wholesale markets and traditional markets. The strategy also plans to strengthen the resilience and the sustainability of the development of the agricultural sector in Morocco, as well as to improve the quality and the capacity of the sector to innovate, for example by reinforcing sanitary controls. The implementation of the new strategy requires an annual increase of the budget for the agricultural sector of almost 2.5% from 2020 onwards.

The strategy *Génération Green 2020-2030* provides a performance contract to develop the horticultural sector. The most important levers are an increase of the cultivated area, an improvement of the productivity and quality, an increase of the export and the development of the volumes of conditioned and processed products. The performance contract will be organized around five main lines of action:

1. Increase of the cultivated area and improvement of the yields and of technical operations;
2. Development of new capacity for the packaging and transformation of agricultural produce;
3. Structuring of distribution channels on the national market, diversification of products and export markets, and an increased traceability along the entire agricultural value chains;
4. Strengthening of efforts in research and development;
5. Development of a new generation of professional organizations.

Quantified targets for the sectors and action lines are under development. The new strategy for agriculture will be implemented from 2020 at the regional level.

With regard to water supply for agriculture, the Moroccan government has also launched the construction of an irrigation system sourced by the desalination plant of the city of Agadir (operative in March 2021). The plant is destined to supply water to the city of Agadir, and the irrigation system is connected to supply the Chtouka plain (15.000 ha), particularly for crops with high added value. This initiative is part of the national plan for the supply of drinking water and irrigation water over the period 2020-2027, that was launched by the government in January 2020. This plan aims to consolidate and diversify water resources to guide the water demand, to provide a secure water supply and to combat the effects of climate change.

Another project supporting the water supply for agriculture is the modernization of the irrigation area of Aoulouz (4486 ha) in the region of Souss-Massa, benefiting 6000 farm enterprises and 7 water user associations. The project consists of the transformation of the traditional furrow irrigation system, which leads to large water losses, into a localized irrigation system with a higher water use efficiency. The envisaged increase of the farm income is between 4.000 and 28.000 DH of added value per ha.

2 Research question and method

2.1 Research questions

This project investigates the impact of activities of the potato value chains as part of a regional food system on the SDGs and their underlying targets and indicators. The project also gives recommendations as to how negative impacts can be minimized and positive impacts can be further enhanced (at the regional level).

The aims of the project are:

- Basic analysis and description of the potato products value chains;
- Analysis of the impact of activities with regard to selected SDGs;
- Recommendations for Dutch projects investing in the potato chains industry.

Thus, in concrete, the following will be studied:

- How can the potato products value chains be described?
- How are the value chains developed in Morocco at this moment, and how is the estimated development within the coming years?
- Which sustainability factors are involved in different steps of the value chains (like f.e. use of water, nutrients, pesticides, energy; losses of inputs and harvest, quality, employment, education, etc.)?
- How can negative impacts be minimized and positive impacts be enhanced (targets)?
- Which stakeholders are involved or have to be engaged?

2.2 Research method

The research was undertaken in several steps:

- Based on existing literature on potato cultivation and potato value chains, a framework was developed that depicts the potato value chains and related Sustainable Development Goals. However, as this scheme is generic more information was needed on the situation in Morocco.
- A further literature analysis revealed that there is limited information in peer reviewed literature about the potato culture and processing in Morocco.
- Through an internet search, stakeholders in Morocco and in the Netherlands were identified. Two interviews were held with Dutch companies trading seed potatoes in Morocco to hear their view on the situation in Morocco. Three stakeholders in Morocco, mentioned by the Dutch Embassy in Morocco and the Dutch seed companies, were interviewed by phone. During the interviews a semi-structured interview list was used, differentiated to governmental and non-governmental respondents (see Annex 1). In two cases the list of questions were sent to respondents who provided written feedback on the questions.
- Based on the gathered information an analysis was made of the actual potato value chains, its current state of development and the estimated development in the coming years.
- For each step relevant SDGs were determined.
- We determined which sustainability factors, related to the SDGs (2, 12, 13, 14, 15, 17) are involved in different steps of the value chains and their (negative or positive) impacts. Herein, we distinguished between two overall transition pathways: the direction of more intensive agriculture resulting in 'smart' (i.e. technological) agriculture and a pathway 'towards organic production'.

Based on the information gathered, challenges and risks were identified and recommendations for sustainable potato chains were outlined.

3 The potato chains in Morocco

3.1 General situation

In Morocco, agriculture currently employs about 38% of the nation's workforce (Worldbank, Tradingeconomics.com). Thus, it is the largest employer in the country. The potato sector is the most important among the sectors of horticultural products in Morocco¹. The cultivation of potatoes has a significant contribution to the agricultural production value of Morocco, and the demand for this product is increasing¹. This product is tenth on the list of most produced commodities in Morocco for which approximately 0.8% of the country's cultivated arable land is used². The region in which potatoes are cultivated is indicated within the frame shown in Figure 1. This coastal region has a Mediterranean climate², with hot dry summers and mild wet winters. Rain falls from November to March and the amount of rainfall varies from 800 mm in the north (Gharb plain) to less than 200 mm in the Sous valley in the south.



Figure 1. Main region in which potatoes are cultivated

Figure 2 depicts the production area (ha), production (tonnes) and yield (tonnes/ha) in the period from 2007 – 2017. The area used for the cultivation of potatoes comprises ca 65.000 ha and did not change substantially since 2007, but both production capacity and yield increased with approximately 25% after 2010 and then stabilized more or less to a new constant level towards yearly ca 30 tonnes/ha, respectively. The Ministry of Agriculture of Morocco reports an average annual production of 1.8 Mtons, of which 50.000 tons are exported¹. In 2019, the national production amounted to 1.9 Mtons³

The sector currently has between 50.000 and 60.000 small and medium-sized agricultural enterprises with irrigation facilities. The size of fields per holding ranges from 0.5 to 3 ha (Benabdellah & El Harrak, 2020). The regional data for 2017 are listed in Table 1. There are big differences in production level between the regions. The production is highest around the big cities (Casablanca, Rabat) and in the rich regions (Tanger). Souss-Massa has a lower production level, but shows the highest cost-efficiency. This region is connected to the desalination plant at Agadir. The agricultural sector in the region has thrived remarkably under the operation Green Morocco Plan and has benefited from the structuring project Agropole Agadir⁴.

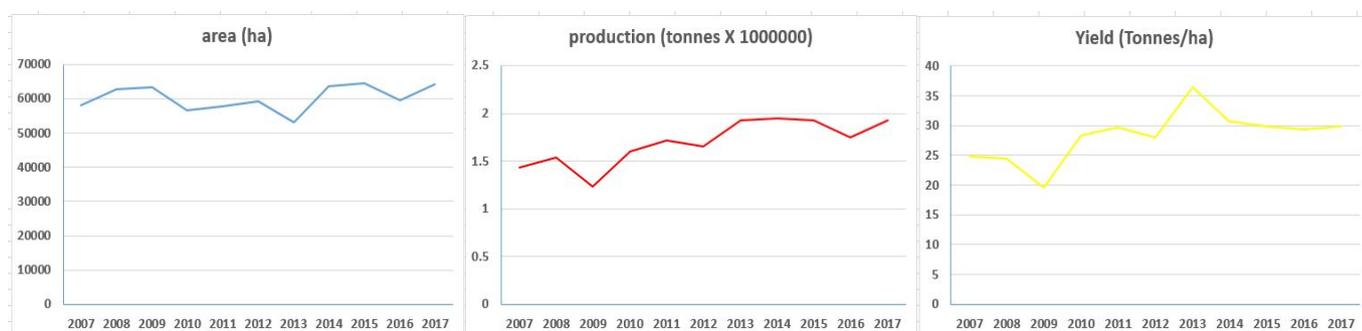


Figure 2. Area of potato cultivation (ha), production capacity (Mtonnes) and yield with the period 2007 – 2017 (Source: FAO-stat)

¹ Source: interview with the Ministry of Agriculture, Fisheries, Rural Development, Water and Forestry (*Ministère de l'Agriculture, de la Pêche Maritime, du Développement Rural et des Eaux et Forêts*)

² <http://www.yieldgap.org/morocco>

³ Source: interview with the Moroccan association of potato producers, FIFEL.

⁴ <https://www.soussmassa.ma/en/agriculture>

With changing consumption habits and an increasing offer on the national markets, the consumption of potatoes in Morocco currently amounts to approximately 1.5 M tonnes (Benabdellah & El Harrak, 2020).

The potatoes are cultivated in four different seasons. In December a separate cultivation takes place, intended for export. The other cultivations are directed to the local market. The cultivation seasons are summarized in Table 2.

In 1969 an official catalogue⁵ was installed by law listing the varieties that may be officially imported, reproduced and commercialized in Morocco. This catalogue is maintained by the National Office for Food Safety of Morocco and lists around 270 varieties with inscription dates since 1982 and the name of the company or organization responsible for the inscription.

From this list fifty varieties, either with yellow or with red skin, are grown in Morocco as they are adapted to the physical-pedological conditions of the country. The choice for some variety depends on the season. The most cultivated varieties are summarized in Table 2, from which Désirée (red skin) covers 50% of the cultivated areas, while Spunta is the most popular variety with yellow skin.

The demand for potato seed is 150.000 tonnes/year on average (*Source: from interview INRA and Ministry of Agriculture*). Approximately, 130.000 tonnes are used for the cultivations of the main season (*culture de saison*), the after-season (*culture de l'arrière-saison*) and the upland cultivation (*culture de montagne*), while 20.000 tonnes are reserved for the cultivation of the early potatoes (*culture de primeurs*). Approximately 35% of the certified potato seed is imported from other countries⁶, mainly from Europe, among which The Netherlands is an important distributor. 2% comes from national production of certified seedlings. The rest of the potato seed is taken from mixed produce of the main season and the other afore-mentioned cultivations.

Table 1. Regional data for production area (ha), production (tonnes) and yield (t/ha) of potatoes in different regions in 2017 (*Source: from interview FIFEL*)

Zones	Area (ha)	Production (T)	Yield (t/ha)
BENI MELLAL - KHENIFRA	2800	60700	21,7
DRAA - TAFILALET	275	5345	19,4
FES -MEKNES	9945	318240	32,0
GRAND CASABLANCA - SETTAT	12960	384290	29,7
GUELMIM - OUED NOUN	200	3760	18,8
MARRAKECH - SAFI	3737	74656	20,0
ORIENTAL	4642	127011	27,4
RABAT - SALE -KENITRA	12330	380915	30,9
SOUS - MASSA	2455	79295	32,3
TANGER - TETOUAN - AL HOCEIMA	9531	254803	26,7
Total	58875	1689015	25,9

Table 2. Potato cultivation information on seasons, varieties, use and cultivation regions (*Source: from interview FIFEL*)

	Month	Varieties	Use	Regions
Early-season cultivation <i>primeurs</i>	Planting in September-October	Nicola, Roseval, Charlotte, Aida, Innova, Timate, Isabel, Yesmina	For local seed	Along the Atlantic coast from Kenitra to El Jadida and Agadir-Taroudant
	Planting in December (from imported seeds)		For export	

⁵ Available at: http://www.onssa.gov.ma/images/controle_semences/Homologation_varietes/Varietes_inscrites_catalogue_officiel/LISTE-CATALOGUE-POMME-DE-TERRE.pdf

⁶ Source: interviews with INRA-Moroc and the Ministry of Agriculture of Morocco.

Main-season cultivation (<i>saison</i>):	Planting in January-February. Seeds from foreign or local sources	Désirée, Spunta, Mondial, Liseta, Kondor, Barna, Atlas, Escort, Burren	Local market	Coastal regions: Loukkos, Doukkala and Moulouya Inland regions : Tadla, Haouz, Chaouia and Saïs
Late-season cultivation (<i>arrière-saison</i>):	Planting in August. Seeds from production of the main season.	Désirée, Spunta, Kondor	Local market	
Mountain cultivation (<i>montagne</i>):	Planting in May	Désirée, Spunta, Kondor	Local market	This type of potato cultivation is mainly practiced in the valleys of the Middle and High Atlas mountains. The main production zones are: Middle Atlas and High Moulouya (la Haute Moulouya)

The Moroccan potato supply chain is depicted in Figure 3 (from Moroccan perspective). The most important part of the potato chain in Morocco is the primary production. Most farmers are smallholders with an average farm size of 1.6 ha/farm (Source: from interview FIFEL). Most of the produced potatoes are sold to the consumer, while processing of potatoes hardly occurs. The relations between producer and consumer are indicated in figure 3. The figure shows that there is a large number of intermediary parties between producers and consumers. In combination with the unstructured character of the distribution networks this causes farmers to encounter difficulties in marketing their potatoes⁷.

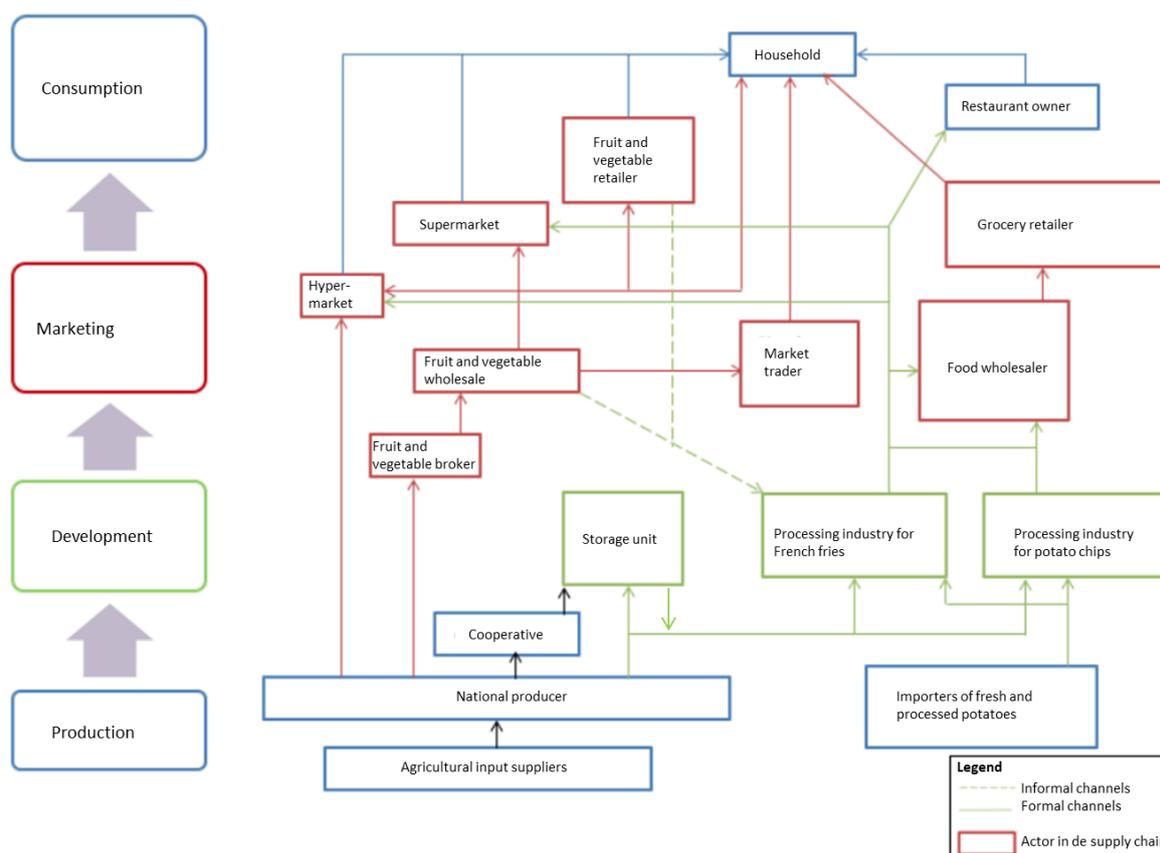


Figure 3. Elements and actors in the potato value chains in Morocco. (Source: Benabdellah & El Harrak, 2020).

⁷ Source: interview with the Interprofessional Moroccan Federation for the production and export of Fruits and Vegetables (FIFEL)/ Association of Potato Producers in Morocco (*Fédération Interprofessionnelle Marocaine de production et d'exportation des Fruits et Légumes/ Association des Producteurs de Pomme de Terre au Maroc*)

On average, each Moroccan consumes about 42 kg of potatoes per year (Source: FIFEL). Seed potatoes are mainly imported (61% of the total demand) (FIFEL, pers. comm.), mostly from the Netherlands (65% of all imported seed potatoes; Source: interviews Dutch seed potato companies). Considerably lower numbers on the import of seed potatoes were mentioned by the respondents from the Ministry of Agriculture (47.000 tons per year on average, corresponding to 32% of the demand) and the national institute for agronomic research (INRA-Maroc) (40.000-50.000 tons per year, corresponding to 36% of the demand).

The main Dutch suppliers are Agrico (20.000 – 50.000 tonnes/yr) and HZPC (10.000 tonnes/yr, of which ~ 60% is the cultivar Désirée). Seed potatoes are used for the production of consumption potatoes. A small part of the potatoes harvested are stored for reuse as seed potato in the next season. The rest is either used for sale to consumers or processed further into chilled, frozen potatoes or chips. Processing of potatoes is only a minor activity in Morocco, i.e. at most 10% (Source: FIFEL). The potato value chain (from Dutch perspective) is shown in Figure 4 and represents a generic potato chain. The figures 3 and 4 show some differences: In the Dutch diagram the industrial part of the value chain is more manifest, while in the Moroccan diagram the actors are displayed in more detail.

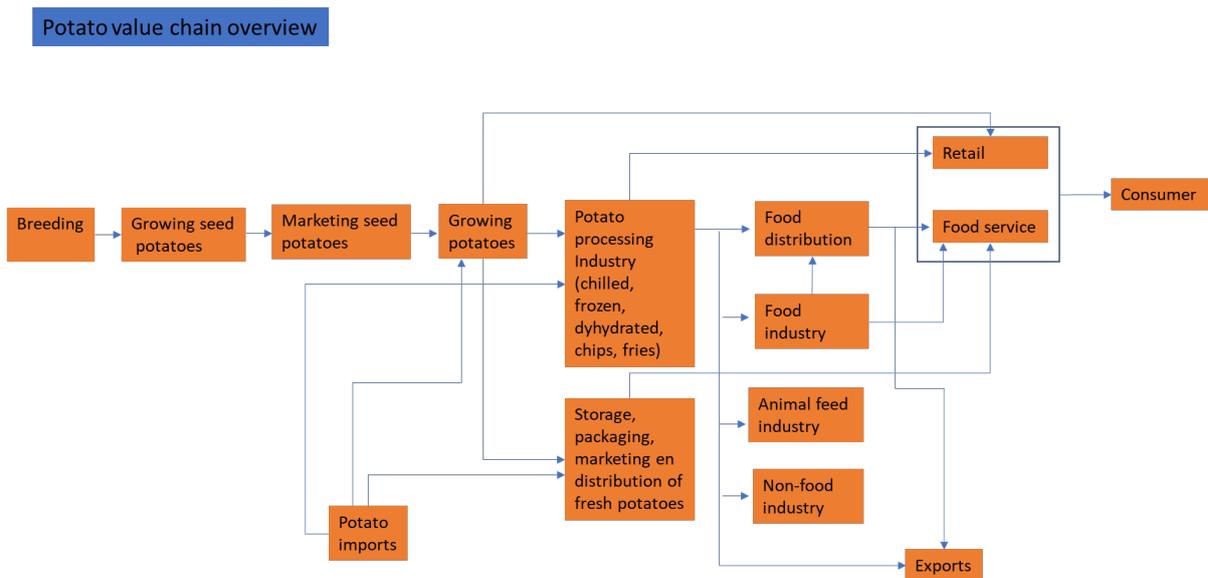


Figure 4. The potato value chain (Source: Rabobank)

The market price of potatoes is not well regulated in Morocco (open market). It varies on a day-by-day basis, depending on trading, supply and demand. Prices vary depending on the regions, the period of the year and the quality of the products⁸. Retail traders are free to set the selling prices. They explain the price fluctuations by the need to cover the risk of selling a perishable product. Because they are at the end of the marketing chain, they often receive the potatoes in bad condition due to transport, loading and unloading, storage or other (Benabdellah & El Harrak, 2020).

There is some level of organization of potato producers in Morocco, but a better organization of the production and marketing within cooperatives could make the commercial environment more beneficial for producers (source: interview FIFEL). Farmers are badly organized in a Farmers' Cooperative, but there is a significant social control between farmers.⁹

Under the Morocco Green Plan (*Plan Maroc Vert, PMV*), Morocco's strategic plan for the development of the agricultural sector which was in force between 2008 and 2020, measures were implemented to create producer associations which are federated in cooperatives¹⁰. The cooperatives function as focal points for the government. The Moroccan Association of Potato Producers (PPM) was created in April 2015 and is member of the Interprofessional Federation for the Production and Export of Fruits and Vegetables (FIFEL).

⁸ Source: interview with the Ministry of Agriculture, Fisheries, Rural Development, Water and Forestry (*Ministère de l'Agriculture, de la Pêche Maritime, du Développement Rural et des Eaux et Forêts*)

⁹ Mentioned by Agrico

¹⁰ according to the law n°03-12 on cooperatives for agriculture and fisheries

The Morocco Green Plan also provided incentives for the adoption of a collaboration model for farmers with private actors and professional organizations. The collaboration model is intended as a win-win partnership between producers at the upstream part of the value chain and commercial and industrial actors at the downstream part. It should help to overcome constraints imposed by the fragmentation of land tenure structures by enabling agricultural enterprises to benefit from modern production techniques and to enter on the internal and external markets¹¹.

3.2 Farm management

The growing of potatoes strongly depends on irrigation performed either by drip or furrow, especially for cultivations without proper tillage¹². The water used is supplied by artesian wells (i.e. groundwater wedged between layers of rock and under pressure) via boreholes, irrigation ditches or wells (Figure 5). The development of drip irrigation systems and the dissemination of advice on irrigation benefit a more water-efficient irrigation, with less percolation to the groundwater and less runoff to water streams. The development of drip irrigation systems is essential for the potato in Morocco, that is facing severe constraints from water shortage due to periods of drought and overexploitation of groundwater resources (Schyns & Hoekstra, 2014) and ¹³.

Opinions amongst respondents on whether or not pollution of soils, groundwater or natural environment occurs, vary. There is research from Morocco showing nitrogen pollution from agriculture and to a lesser extent pesticides in some of the more intensively farmed areas in Morocco (Fetouani et al., 2008; Malki et al., 2017; Oumenskou et al., 2018) - no specific study for potatoes cultivation however was found.

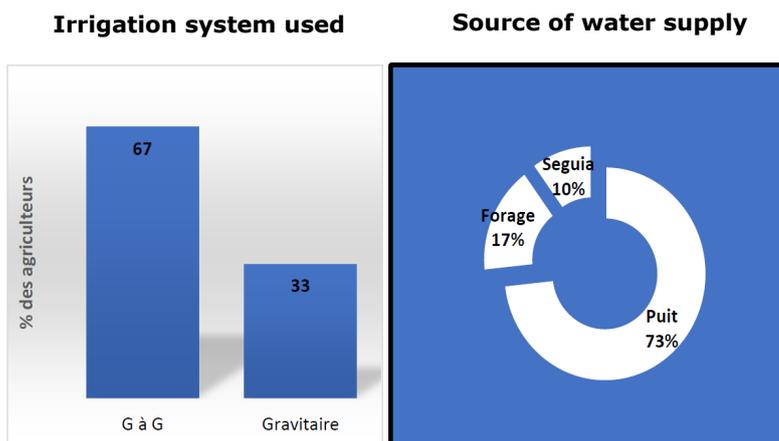


Figure 5 Left: Percentages of farmers, that supply water by drip (G à G) or furrow irrigation (Gravitaire); Right: percentages of water supply from boreholes (Forage), ditches (Seguia) or wells (Puit). Source: FIFEL.

The supply and scheduling of fertilizers is summarized in Table 3. Apart from the supply of mineral fertilisers (NPK), also 156 kg magnesium sulphate (32% Mg) and 70 kg calcium are added. Total N-supply is in accordance with normal supply for potato (around 250 kg/ha total gift)¹⁴, while the total supply of P appears to be high (around 100 kg/ha). Probably the soil lacks P supply capacity, for which also extra calcium and Mg are added to enhance the release of P from soil particles. The disease pressure on potatoes in Morocco is big and increasing (Achbani et al., 2015), since the weather conditions become more severe, like long lasting drought in the regions around Marrakesh and more wetness in Meknes¹⁵. Pests and diseases arising in Morocco are: Fungi (Phytophthora, Alternaria, Rhizoctonia, Fusarium, Verticillium); Bacteria (Streptomyces, Erwinia); Viruses (Y, X, leafroll, mosaic); Insects (Aphids, ringworm) and Nematodes.

¹¹ Source : <http://www.agriculture.gov.ma/pages/le-modele-de-lagregation>

¹² Source: interview with the Ministry of Agriculture, Fisheries, Rural Development, Water and Forestry (Ministère de l'Agriculture, de la Pêche Maritime, du Développement Rural et des Eaux et Forêts)

¹³ Source: interviews with INRA-Maroc, FIFEL and the Ministry of Agriculture.

¹⁴ See: <https://www.haifa-group.com/crop-guide-potato/potato-fertilizer-recommendations>

¹⁵ <http://www.yieldgap.org/morocco>

Table 3. Quantity (tonnes/ha) and timing of fertilisers. (Source: FIFEL)

						N	P2O5	K2O	
organic manure, the N/P/K contents estimated from dutch cow manure									
	organic manure	5	kg N/t	30	t/ha	150			
		3	kg P2O5/t				90		
		6	kg K2O/t					180	
before planting									
	ammonium sulfate	21%	N	150	kg	32			
	superphosphate	18%	P2O5	850	kg		153		
	potassium sulphate	48%	K2O	400	kg			192	
side dressing									
	ammonium nitrate	34%	N	300	kg	101			
						N	P2O5	K2O	
						282	243	372	kg/Ha

Measures like crop rotations, adequate phytosanitary facilities, etc. are hard to implement in the farm management in Morocco, because many farmers are poorly educated and often lack knowledge on technical issues¹⁶.

A general approach in pest management is:

- a treatment with herbicide before emergence;
- one or two preventive treatments against mildew with Mancozeb (*Mancozèbe*) (Dithan M45, 250g/hl of water and 5 to 6 hl/ha), Maneb (200g/hl of water and 5 to 6 hl/ha), copper (Kocide 101-400 g/hl and 5 to 6 hl/ha), etc.;
- a chemical treatment against moth with Methomyl, Azimphos methyl and Métamialphos etc.;
- Integrated Pest Management (IPM).

Given the relatively dry conditions prevailing in Morocco, the above mentioned treatment with pesticides are suitable to combat Phytophthora. IPM is applied in the production¹⁷, and is considered by the Ministry of Agriculture as one of the challenges for the potato sector in the country¹⁸.

According to the information from one of the respondents, the certified potato seed coming from other countries does not meet an acceptable quality on a phytosanitary level (presence of *Streptomyces* spp and of *Pectobacterium* spp), in addition to their high price, between 6 and 14 Dh/kg (or 0.6 to 1.27 Euro/kg; Source: FIFEL).

Mechanization is only partly implemented in the farm management. According to the registrations, currently 50% of the agricultural enterprises uses machinery from preparation to harvest¹⁹. The harvest is often performed by the women. Most harvested potatoes (90%) are sold at the local market for direct consumption; 3% is exported and 5-7% is stored for processing.

The distribution network is unstructured, with a large number of intermediaries, leaving only a very low profit margin amounting to 0.35 Dh/kg. For a production of 30 tonnes/ha, the farmer makes a profit of 10.500 Dh/ha (or 954 Euro/ha) (Benabdellah & El Harrak, 2020).

The support for farmers and the transfer of agricultural know-how to the field are handled by the local offices of the National Office of the Agricultural Council. Each of these offices provide support and monitoring to potato producers in their zone of action²⁰.

¹⁶ Interview Agrico, FIFEL

¹⁷ Interview FIFEL

¹⁸ interview with the Ministry of Agriculture, Fisheries, Rural Development, Water and Forestry (Ministère de l'Agriculture, de la Pêche Maritime, du Développement Rural et des Eaux et Forêts)

¹⁹ Source: interview INRA-Maroc

²⁰ Source: interview FIFEL.

3.3 Storage

Most potatoes are consumed directly and stored during a short period, less than 3 months. The most frequently used methods in Morocco are the traditional methods²¹:

- storage in the soil, in the field (which is used to delay the harvest) until one month after ripening;
- in the field without shelter, in the shadow of trees, or under sheds, where tubers are covered with either hay, straw, dry grass or leafstalks;
- storage below trees in the forest. The potato tubers are piled up in the forest and covered with straw (duration: 30 to 60 days);
- placing of the potatoes in bulk on the floor of buildings (cool and deficient in light).

This practice does not allow compliance with conditions of temperature and humidity, and causes loss of weight and a deterioration of the quality of the tubers:

- Considerable loss of weight due to respiration and transpiration of the tubers (low relative humidity during storage) (<80%);
- Decrease of quality due to dry rot (high temperature during storage) (> 25°);
- Early triggering of germination due to diffuse light.

Improved traditional methods are also used for the storage of potatoes in Morocco²¹: refrigerated storage of potatoes from the main season on bulk product or packed in boxes in a ventilated building or in a ventilated room which is moistened. Temperature regimes for this type of storage are summarized in Table 4. The relative humidity applied in refrigerated storage of potatoes is 90 to 95%, while the accumulation of CO₂ is prevented through ventilation. Currently, refrigerated storage is still rarely used as it is a costly technique, although the Moroccan government provides subsidies to stimulate the use of it in the framework of the Agricultural Development Fund (*Fonds de Développement Agricole*, FDA²²) and in the new strategy *Génération Green* (Source: interview INRA and Ministry of Agriculture).

Table 4. Temperature regimes in refrigerated storage of potatoes. Source:FIFEL.

Duration of storage	Destination of the production	Storage temperature
Less than three months	Consumption	8 to 10° C
	Processing	8 to 10° C
	Seed	5 to 12° C
More than three months	Consumption	4 to 7° C
	Processing	7 to 8° C
	Seed	2 to 4° C

Potatoes meant for seed production are stored in scattered light, implying that the tubers are exposed to indirect radiation to inhibit sprouting. This storage is an alternative method for the refrigerated conservation and may last between 3 and 4 months.

3.4 Processing

The quantity of processed potatoes does not exceed 10% of the volume produced (source: FIFEL). Morocco does not have any large modern manufacturing plant for frozen fries, and imports almost 35.000 tonnes of that product per year. The same applies to potato starch; the import of this substance varies between 5 and 10 millions of tonnes per year (Source: FIFEL).

Obstacles for the development of this part of the chain are: high costs for refrigerated storage which farmers cannot afford, the limited technical skills of the producers, the dependency of the sector on the import of seeds, especially seeds with a high capacity for valorisation (e.g. for processing) and the

²¹ Source: interview INRA-Maroc

²² The target of the Agricultural Development Fund is to promote the investment of private funds in the agricultural sector and to guide the sector to a better exploitation of the country's agricultural potential. Source: <http://www.agriculture.gov.ma/fda>.

high prices of these seeds (6 to 14 Dh/kg) (Benabdellah & El Harrak, 2020), the limited use of / access to certified seed and the lack of diversification, coupled to the difficulties in marketing that farmers encounter (unstructured distribution networks with a large number of intermediaries). Furthermore, the weak organization of the chain and the lack of infrastructure for storage and processing complicates the valorization of processed products (source: FIFEL) .

The industrialization in this sector just starts. Currently, the local production of chips is done by a single Moroccan food-processing company, namely LeaderFood, since 1999 (source: FIFEL) .

Apart from constituting a very coveted vegetable by the Moroccan consumer, the potato has a large potential for development according to the Moroccan association of potato producers (FIFEL)²³. Farmers should be aware of the need to organise themselves into Agricultural and Farmers' Professional Organization (*OPA*) to meet the national demand for value-added products (fries, chips, etc.), both in terms of quantity and quality. In this regard, the government grants subsidies and financial support for development projects in the potato branch under the Morocco Green Plan and the new agricultural strategy *Génération Green*²⁴.

²³ Source : interview FIFEL

²⁴ Source: interview with the Ministry of Agriculture

4 Relevant SDG for the potato chain in Morocco

4.1 Introduction

The Sustainable Development Goals address a multitude of issues from poverty reduction, good health to international co-operation. In many cases there are various interrelations between the SDG – for instance SDG 2 Zero Hunger aims to end hunger, achieve food security and improved nutrition and promote sustainable agriculture, whilst SDG 1 aims to reduce poverty. Food security and a better income will also protect smallholder farmers from poverty. Therefore, in table 5 an overview is given of the most relevant SDGs related to the potato chain in regards to its sustainability. This overview is based on existing literature and experiences regarding the potato chain in other countries. A distinction is made according to the different stages of the potato chain.

One of the instruments developed to assess the sustainability of the potato cultivation and to guide and stimulate actions for improvement by farmers, is the Cool Farm tool²⁵. Several indicators are included in this tool that assist farmers in improving the sustainability of their farming practices such as water used for irrigation, reducing greenhouse gas emissions and improving biodiversity on their farm.

Table 5. Overview of general known positive and negative aspects influencing the sustainability of the potato chain and the related SDG

Potato chain stage	Issue	Sustainable Development Goals
Breeding	Better selection on disease and saline resistant potato varieties to respond to climate change (George et al, 2017; Thiele 2017)	9. Innovation and Infrastructure
	Increased nutritional value of potato (Goyer, 2018)	2. No hunger 3. Good health
Growing of potatoes (seed and potatoes for direct consumption and processing)	Pollution of groundwater by pesticides and fertilizers (Jego et al, 2008; Brown et al, 2007; Malki et al, 2017)	6. Clean water and sanitation
	Direct and indirect negative effects of nitrate and pesticides pollution on terrestrial and aquatic species/ ecosystems Direct negative effects of pesticides related to death of non-targeted insects after application, indirect effects related to the long term effects on insects and on other species (through long term exposure or food relationships) (Giglio et al , 2017, Zwart, 2005; Stanley et al., 2016).	14. Life below water 15. Life on land
	Over-exploitation of groundwater and surface water for irrigation	6. Clean water and sanitation 13. Climate action

²⁵ <https://coolfarmtool.org/>

	Risk associated with use of (treated) waste water for irrigation (Chaoua et al., 2019).	3. Good health
	Increase in production of CO2 during growth season (tillage systems, fuel use of machines for tillage and harvesting)	7. Renewable energy 13. Climate Action
	Low / insufficient income of farmers ²⁶	1. No poverty 2. No hunger 4. Good quality education 8. Good jobs and economic growth
	Lack of affordable and good quality seed potatoes	2. No poverty 2. No hunger
	Increase in greenhouse gas emissions due to CO2 production during transport (ref)	13. Climate Action
Storage	Increase in greenhouse gas emissions due to CO2 production during storage	13. Climate Action
	(Energy	7. Renewable Energy
	Post-harvest loss (due to insects, rodents, fungi a.o.)	12. Responsible Consumption
	Loss of quantity and quality during storage	2. no hunger 3. Good health
	Increase in greenhouse gas emissions due to CO2 production during transport	13. Climate Action
Processing	Limit loss of product during processing, reduction of waste (Terry et al, 2011)	13. Climate Action
	Water efficiency, water reuse	6. Clean water and sanitation 13. Climate action
	Energy efficiency during processing, use of renewable energy, re-use of waste product for energy or valorization	7. Renewable Energy 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
	Insufficient working conditions / Labor rights in factory (also due to competition with other countries)	8. Good jobs and economic growth
	Reduction of Greenhouse gas emissions in processing (Mouldry et al, 2013)	13. Climate Action
Consumer	Food loss (products after due date)	12. Responsible Consumption

4.2 Relevant SDGS for the potato chain in Morocco

Based on the current development of the potato food chains in Morocco (see chapter 3), most of the SDGs to be evaluated currently are related to the first part of the value chain (production of potatoes for both consumption and seed potatoes), and to a limited extent to the processing of potatoes, as the parts of the potato chain related to breeding of seed potatoes and processing are not (yet) well developed in Morocco. A large part of the seed potatoes are imported from abroad, therefore the main question is how sustainable the production of these potatoes is in the country of origin and to what extent greenhouse gases are produced during transport of the seed potatoes to Morocco. At present,

²⁶ Source: interview INRA-Maroc and FIFEL

seed potatoes are only certified or rated for quality and phytosanitary standards. For seed potato no (other) criteria for sustainability are considered yet. In addition, from the interviews with Dutch respondents it became apparent that there are several issues regarding limited market demand for high quality of seed potatoes and potatoes with patenting rights. Often potatoes imported in Morocco are lower in quality and phytosanitary requirements are not always as they should be. The processing of potatoes is still in early stages of development in Morocco although it is foreseen that this will increase in the coming years. No information was available yet on the processing plants already operating in Morocco²⁷.

Therefore, the issues that we expect have the biggest impact on sustainability of the potato chain in Morocco in the short term based on the information gathered in this quick scan are:

- **Increase the income of farmers and improve their knowledge.** Income from potato crop in Morocco is low and the average farm size is small (Benabdellah & El Harrak, 2020). Producers have little capacity for investment due to their limited creditworthiness and the high interest rates on loans granted to producers²⁸. In the interviews it was mentioned that many of the farmers have limited formal education and that the system of farming advice and provision of market information to farmers is not well developed.

Improving the profitability of the potato sector and increasing their knowledge will contribute to SDG 1. Poverty reduction and in particular to SDG 2. No hunger target 2.3: *By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment* and Target 2.4: *By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality.*

Improving farming practices during the growing season as well as the quality of the seed production and the availability of seed in the other seasons might be beneficial to improve the yield of individual farms.

- **Efficient use of water for irrigation.** There is already a considerable drain on the water resources in Morocco (Ait Kadi et al. 2018; Malki et al. 2017; Schyns & Hoeksta et al, 2014). Around 33% of the farmers use furrow irrigation to water their fields and the majority of the water (73%) comes from wells. The development of drip irrigation systems and the dissemination of advice on irrigation benefit a more water-efficient irrigation, with less percolation to the groundwater and less runoff to water streams. The Moroccan government is providing subsidies for the installation of drip irrigation systems for preparing for the mobilization and desalinization of sea water in regions that are starting to suffer from water shortage²⁸.

The extent to which water use can be more efficient will have a major impact on the sustainability of the use of water SDG 6. Clean water and sanitation in particular target 6.4: *'By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity'.*

- **Reduce loss of harvest.** The storage practice that is commonly used by farmers is the traditional storage resulting in loss of harvest and a deterioration of the quality of the tubers. Reducing post-harvest losses will contribute to SDG 12 in particular target 12.3 : *By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses.* In addition, better storage practices

²⁷One of the processing factories for potato chips is Leaderfood (since 1999). <http://www.leader-food.com/qui-sommes-nous>. In the course of this research no information could be obtained regarding the sustainability of the processing plant. A new plant [company unknown] is at present being built in Meknes (source: interview INRA-Maroc).

²⁸ Interview with the Ministry of Agriculture, Fisheries, Rural Development, Water and Forestry (Ministère de l'Agriculture, de la Pêche Maritime, du Développement Rural et des Eaux et Forêts)

might also reduce greenhouse gas emissions during storage. At the same time an increased use of refrigerated storage facilities might lead to an increase in the use of energy which might come from fossil fuels.

- Efficient use and reduction of pesticides and fertilizer thus avoiding pollution of groundwater by pesticides and fertilizers.** No information specifically for the potato sector for Morocco in literature was found and respondents expressed different opinions on this matter. The level of use of pesticides and fertilizer is still relatively low and comparable to other countries in similar conditions. However, it was indicated that pressure from diseases affecting potatoes is high in Morocco. In some areas where more intensive farming in Morocco occurs, pollution of groundwater has already been noted (Malki et al, 2017). An overall reduction of the use of fertilizers will reduce the direct and indirect effects on biodiversity as well as decrease the carbon footprint of the potato as the production of particular fertilizer is CO₂-intensive. Until present no studies have been performed on the effects of potato production on biodiversity in Morocco. Compared to other vegetable crops cultivated in greenhouses, the cultivation of potato is relatively extensive, as testified by the small average farm size and the low yield. This might provide chances to develop organic potato cultivation, which is one of the missions of the association of fruit and vegetable producers FIFEL. The use of fertilizer and pesticides during the growing season is also one of the indicators used in the Cool Farm tool²⁹ developed to assess greenhouse gas emissions in agriculture. A change to more intensive farming practices in the foreseeable future, as propagated by the new strategy for agricultural development in Morocco (*Génération Green*), will increase the risk of diffuse pollution of water, air and soil from agricultural sources. Wise use of pesticides and fertilizer use, avoiding overfertilization and avoiding and reducing pollution will contribute to achieving SDG 6 Target 6.3. *By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally.*

Other sustainability issues related to the growing of potatoes at present in Morocco are less important such as:

- fuel use for tillage and machinery as only 50 % of the production is mechanized
- CO₂ production during transport as much of the potatoes are produced for the local markets.

Figure 6 presents a schematic depiction of the potato chain in Morocco (from Dutch perspective) supplemented with the most relevant SDGs.

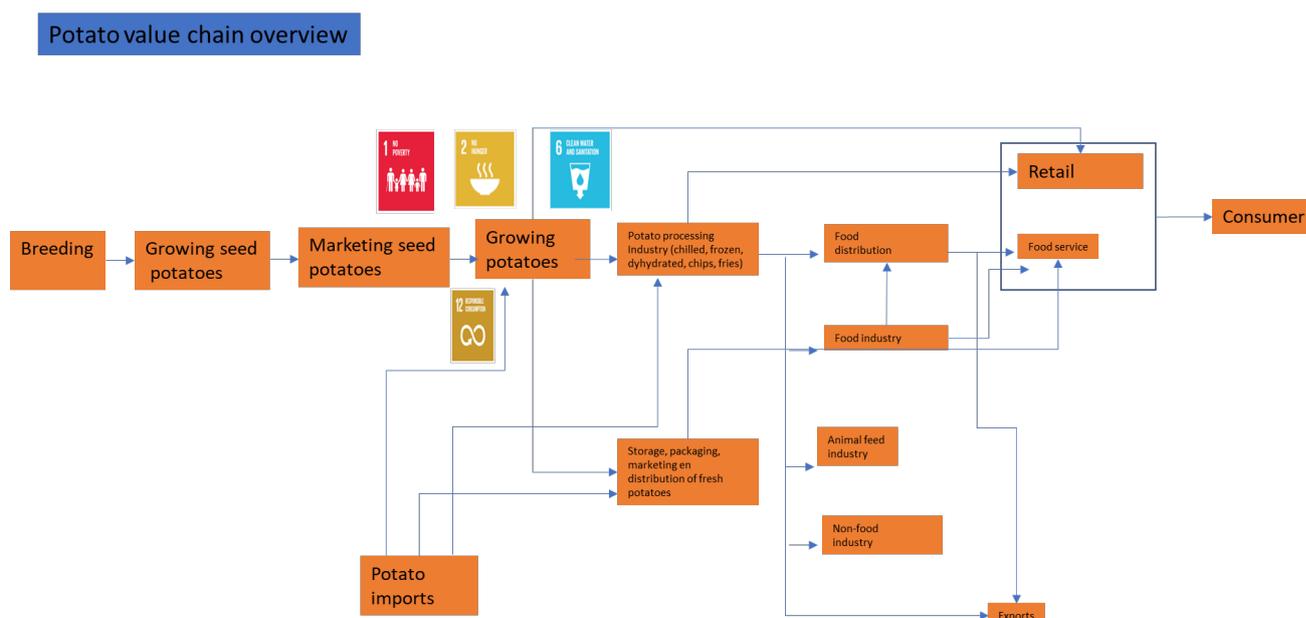


Figure 6. The potato value chain (Source: Rabobank) supplemented with most important SDGs

²⁹ <https://coolfarmtool.org/>

5 Challenges and opportunities in the future to ensure a sustainable potato chain

5.1 Introduction

It is clear from our inventory and interviews that the main focus of the potato value chains in Morocco is at present on primary production. Most of the produced potatoes are sold to the consumer on-farm or on local markets, through retail traders, supermarkets and other intermediary parties, while processing of potatoes hardly occurs. The current growing of potato is still extensive and farm holdings are small. However, with an increase in urbanisation, flow of young fast food consumers to the cities and extension of the middle class, an increase of processed potato products can be noted conform the trend all over the world. This is because the middle class can afford to buy (potato) snacks and eat at restaurants. Moreover, the emergence of a fast food sector that usually serves French fries, is strongly related to the presence of a middle class in upcoming economies.

The agriculture sector in Morocco – and with it the potato value chains - is currently undeniably modernizing rapidly in order to strengthen the agricultural production, to improve the farmers' income and to become competitive at the international market. This ambition also ties in well with the ambitions of the Moroccan government, as formulated the new Strategy for agriculture: *Génération Green 2020-2030* (see chapter 1).

The following directions of development have been mentioned by Dutch and Moroccan respondents and can be expected based on the development occurring in other countries:

- Changes in the potato market and chain development:
 - Introduction of monitoring and control of the quality of consumption potatoes and potatoes for processing
 - Improvement of the connection between (market) demand and supply
 - Development of processing units / facilities? (Storage, processing, packaging, transport)
 - Adaptation of legislation

- Improvement of agricultural practices:
 - a. Certification and quality control of seed potatoes (both imported as well as Moroccan grown)
 - b. Mechanisation; the government envisages a revision of subsidy rates for the use of agricultural equipment in order to stimulate the mechanization in planting and harvesting³⁰
 - c. Introduction technology for precision agriculture (i.e. computer-controlled irrigation systems in the field with data collection for supply on demand and aiming at the saving of water use, nutrient supply and application of pesticides)
 - d. Development of storage and conditioning facilities. Investments in these facilities by private actors are supported by the Agricultural Development Fund (Fonds de Développement Agricole, FDA)³¹
 - e. Education, training, capacity building. The development of a new generation of professional organizations to accommodate these activities is foreseen in the strategy *Génération Green* (chapter 1).

³⁰ Source: interview with the Ministry of Agriculture.

³¹ The target of the Agricultural Development Fund is to promote the investment of private funds in the agricultural sector and to guide the sector to a better exploitation of the country's agricultural potential. Source: <http://www.agriculture.gov.ma/fda>.

For the potato production in Morocco two overall transition pathways can be outlined: one pathway in the direction of more intensive agriculture resulting in 'smart' (i.e. technological) agriculture, another pathway in the direction 'towards organic production'. The first pathway aims to increase production and knowledge of farmers. This will finally lead to farms using modern Information and Communication Technologies to increase the quantity and quality of products while optimizing the required human labour and optimising the use of fertiliser and pesticides for the reduction of environmental pressure.

The second pathway of the transition to organic farming aims for integrated farming systems that strive for sustainability, enhancement of soil fertility and biological diversity while, with rare exceptions, prohibiting the use of synthetic pesticides, antibiotics, synthetic fertilizers, genetically modified organisms, and growth hormones.

Given the current situation of the potato cultivation in Morocco, and given the ambitions of the new strategy for the agricultural sector, *Génération Green*, it is highly likely that the Moroccan agriculture will follow the pathway of increased intensification that is dominant in most parts of the world (Tilman et al., 2011).

Both transition pathways have different challenges for the degree of sustainability that will occur whilst the agricultural sector is changing (see figure 7). A challenge that both pathways have in common is that during the change of agricultural potato production in Morocco the size of farms is very likely to increase while at the same time the number of farmers will decrease. An increase of the cultivated area and improvement of the yields and of technical operations is one of the lines of action of the strategy *Génération Green*³². The need to improve the livelihood of farmers in order to reduce poverty, to avoid hunger and to offer farmers and hired farm labourers decent working conditions will be a driver for this development as is also the need to be competitive on the international market.

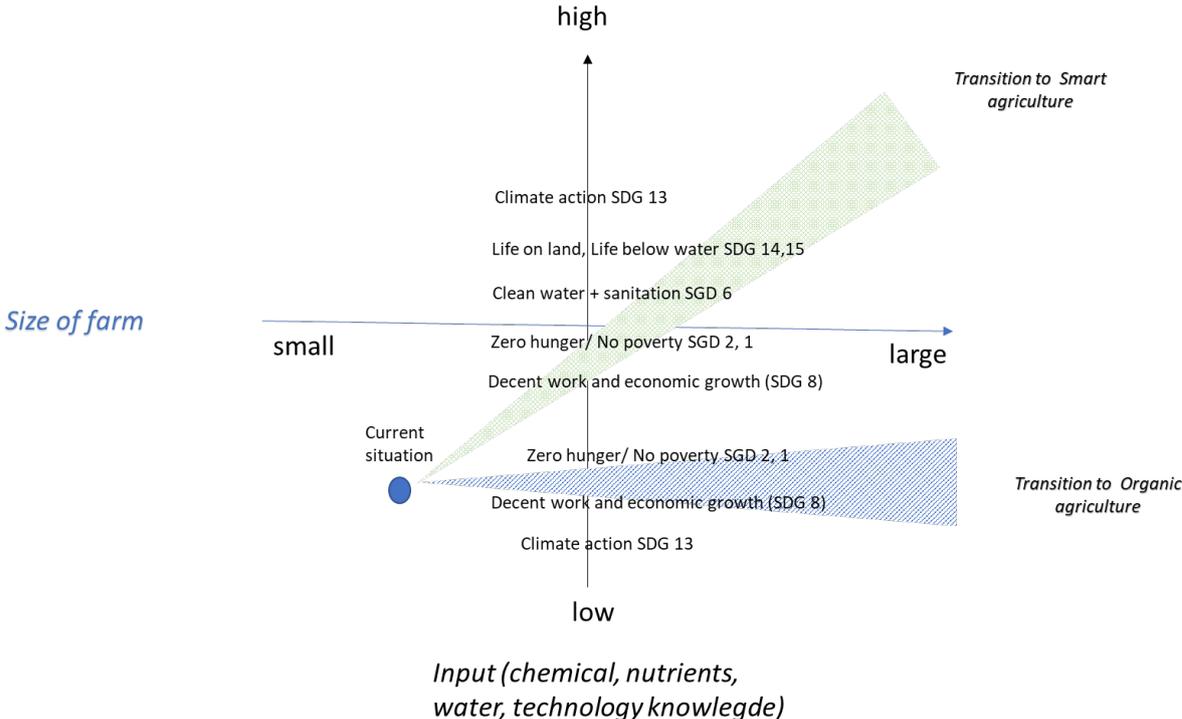


Figure 7. SDGs that need to be considered during the two development pathways of the potato cultivation

At the same time, the potato processing industry will develop as well. At present the potato processing industry is still relatively small although new factories are foreseen in the near future. The challenge for the potato processing industry will be to be (come) climate neutral, to reduce waste and energy use, as well as to re-use of as much residual products as possible (circular economy). Worldwide developments in this field are going fast but in Morocco most processing factories still need to be built.

³² Source: interview Ministry of Agriculture

Morocco may have a unique opportunity to design and to build production facilities conform to the latest standards in this field. However, this might require initial larger investments.

In the next paragraph we will provide further details on the challenges posed during the transition of agricultural sector and potato chain in Morocco.

5.2 Suggestions for further development

Without outside interventions (e.g. from the government, businesses or through trade agreements or international agreements), the potato production chains will develop autonomously anyhow conform global trends and market mechanisms. The innovations going along with this development may both improve or deteriorate the level of sustainability. In order to diminish or prevent negative effects and stimulate positive effects on sustainability, suggestions can be made on how to deal with the innovations and to guide choices and (political) strategies that may affect the transition towards more sustainable agriculture positively. To be able to make suggestions for the innovation of the potato chains, development factors might be held against the sustainability bar, as depicted in Table 6. Herein, the opportunities and risks for specific aspects of the transition of the potato value chains are indicated.

Table 6 Comparison between development factors and (groups of) sustainability goals

	Improvement economic situation (SDGs 1,2)	Wise use and protection of natural and energy resources (SDGs 6, 7, 13, 14, 15)	Innovation and infrastructure (SDGs 9,12)
Quality control consumption potatoes	<i>Opportunities:</i> yield increase, employment, spreading sales, opening international market, possibilities for processing <i>Risks:</i> high investments, rejection of batches of potatoes	<i>Opportunities:</i> decrease use of fertilisers or pesticides (zero tolerance residues) <i>Risks:</i> waste due to rejection of potatoes	<i>Opportunities:</i> healthy (nutritious) products <i>Risks:</i> complexity of logistics
Connection between demand and supply	<i>Opportunities:</i> increase of production level, prevention of waste; increase market share; higher income, stimulation of entrepreneurship <i>Risks:</i> corruption, some cultivars (Spunta) become out of interest which might be a threat for smallholders	<i>Opportunities:</i> Less waste of resources by better sale products (i.e. lower carbon and water footprint) <i>Risks:</i> miscommunication between actors within the chain	<i>Opportunities:</i> better logistics, higher quality standards, broadening product range <i>Risks:</i>
Equipment and technology for processing	<i>Opportunities:</i> increase income technology sector, increase export <i>Risks:</i> smallholders become out-competed	<i>Opportunities:</i> <i>Risks:</i> more water and energy needed	<i>Opportunities:</i> <i>Risks:</i> increase welfare diseases (obesity)
Legislation	<i>Opportunities:</i> price fixing; control costs, subsidies,	<i>Opportunities:</i> more attention for saving	<i>Opportunities:</i> more attention for optimization

	lowering interest rates on loans <i>Risks:</i> illegality	resources; control by imposing constraints <i>Risks:</i> illegality (pesticides), need for monitoring and enforcement	of logistics and for healthy diets <i>Risks:</i>
Certification seed potatoes	<i>Opportunities:</i> Better yields <i>Risks:</i> rejection of parties	<i>Opportunities:</i> selection of low input varieties, better control of diseases and thus lower application of pesticides <i>Risks:</i>	<i>Opportunities:</i> <i>Risks:</i>
Mechanisation	<i>Opportunities:</i> Yield improvement, stimulation of entrepreneurship, more employment, increase in welfare <i>Risks:</i> need for skills / knowledge, loss of jobs, low educated people may have problems with use of equipment, high investments/costs	<i>Opportunities:</i> <i>Risks:</i> increased water and energy use	<i>Opportunities:</i> less manual work (healthier) <i>Risks:</i> accidents by irresponsible use
Precision agriculture	<i>Opportunities:</i> Prevention of yield losses, targeted time schedule, attraction of young adults <i>Risks:</i> high investments	<i>Opportunities:</i> Efficient use of water and nutrients, ... <i>Risks:</i> use energy	<i>Opportunities:</i> reduction nutrient leaching, reduction pollution by chemicals, use low quality soils <i>Risks:</i> increase carbon footprint
Storage and conditioning facilities	<i>Opportunities:</i> increase of product range and marketable product, improvement market position, increase international trade, .. <i>Risks:</i> no market available (not yet), high investments (equipment, knowledge / skills)	<i>Opportunities:</i> decrease of waste streams of unsold potatoes due to increase in marketable product <i>Risks:</i> higher energy use	<i>Opportunities:</i> <i>Risks:</i> waste water, pollution (effluents)
Certification and quality control	<i>Opportunities:</i> access to international markets, .. <i>Risks:</i> investments (knowledge, time and cost of certification mechanism)	<i>Opportunities:</i> driver for lower use of pesticides <i>Risks:</i>	<i>Opportunities:</i> <i>Risks:</i>
Knowledge and skills	<i>Opportunities:</i> will boost and facilitate development <i>Risks:</i> farmers with low education and motivation are unable to adapt to the new situation	<i>Opportunities:</i> saving resources, more sustainable land and water management <i>Risks:</i>	<i>Opportunities:</i> better logistics <i>Risks:</i>

As can be seen from the table, an innovation and extension of the potato value chains will provide many opportunities for improving the economic situation, saving resources and improving resilience and public health. But the risks for increase of the water and carbon footprint (due to higher energy use) are also distinct. This means that the innovations should be accompanied by a strict legislation and need for monitoring and enforcement, and by incentives for the sector to adopt water-saving irrigation systems and renewable energy technology. In general, big enterprises will be more capable to invest in new and high technology, which may cause smallholders to become out-competed. To overcome this risk, smallholders may be stimulated to closely organize in order to be able to exchange equipment, to use common storage facilities, to optimize their logistics in product transport, to have a good negotiation position and to become attractive for banks to invest. This requires a solid governmental promotion and support, while corruption and abuse is guarded closely. The national association of fruit and vegetable producers (FIFEL) performs awareness raising among farmers of the need to organise themselves into Agricultural and Farmers' Professional Organizations (OPA) to meet the national demand for value-added products (fries, chips, etc.), both in terms of quantity and quality³³.

It is hard to choose the best transition pathway between the two outlined above. Both pathways have advantages and disadvantages. Development towards an high-tech innovation may need a strict policy on the enforcement of constraints to avoid the increase of the water -, energy - and carbon footprints. Development towards organic production may need the stimulation of 1. integrated production systems (f.e. potato – dairy farming) to use the opportunities for re-use of manure for nutrients, or 2. Valorization of potato processing residues (f.e. for production of lactic acid; Smerilli and Neureiter, 2016). Both development pathways can perfectly coexist and be stimulated by Dutch governmental strategies.

5.3 Recommendations for Dutch investments in the Moroccan potato chain

From the analysis on development factors against sustainability bar (Table 6) it becomes clear that:

1. High tech innovation will be the most likely development and that a lack of skills will be the most likely risk.
2. In future lack of water and an increase of chemicals and energy usage will be associated with the high tech innovation.

This makes us recommend to invest in skills, farmer-inclusive business development for suitable implementation of the technology and projects on minimizing environmental impacts. As part of the current co-operation between the Netherlands and Morocco, suitable projects in this context that might be considered for financing or other means of support by the Dutch government, Dutch investors or Dutch businesses, are mentioned below.

For projects targeting the potato cultivation/ farm level

1. Invest in projects that support the set-up of education training and capacity building activities for farmers in the field of sustainable agriculture
2. Invest in projects related to minimizing the environmental impacts in the field of water use, nutrient and pesticide use and use of fossil fuels
3. Farmer-inclusive agri-business development: organise farmers towards an efficient market orientation for instance by
 - Putting in place a simplified information system on markets that is accessible for small producers;
 - Develop the potato according to national and international norms for certification with the purpose to improve the quality of the commercial offer;
 - Enable producers to benefit from training sessions on marketing techniques (business practice, information on markets, vertical coordination, ...);
 - Organise the production and marketing in cooperatives managed by staff with competence in these domains.

³³ <http://www.foodfrommorocco.ma/en/acteurs-nationaux/fifel>

For projects related to potato storage and processing:

1. Investing in energy neutral storage facilities and facilities that reduce greenhouse gas emissions
2. Investing in processing facilities that use the latest technologies in the field of
 - a. reducing energy use during production (e.g. use of biogas/ solar energy/ thermal energy)
 - b. efficient water use technologies to reduce water use during production and increase re-use of 'waste' water
 - c. reduction of rest products (e.g. products that are not used for making chips or fries but are left over) and valorization of these products

To strengthen competence in commercial practices (*source*: interview FIFEL):

- Provide training, coaching and support to young producers to strengthen their initiatives to enter the market. These activities should involve the downstream part of the production chain, given the fact that the financial return of producers who sell their product off-farm is higher than that of producers who sell their product on-farm. The new strategy for the agricultural sector, *Génération Green*, also focuses on the development of the downstream part of the agricultural production chains.
- Develop partnerships between farmers and private actors or professional organizations with management capacities³⁴ to respond to the needs of farmers with regard to marketing. In addition, a transparent organization is needed in order to increase the trust of farmers.

³⁴ NT: The 'système d'agrégation' is a collaboration model for farmers with private actors and professional organizations with management capacities in the 'Plan Vert' of the Moroccan Ministry of Agriculture. It is intended as a win-win partnership between producers at the upstream part of the value chain and commercial and industrial actors at the downstream part, that enables to overcome constraints imposed by the fragmentation of land tenure structures by enabling agricultural enterprises to benefit from modern production techniques and to enter on the internal and external markets. Source :

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Annex 1 Questionnaires

For non-governmental contacts

Potato production (seed/ consumables)



1. Can you elaborate on the potato production in Morocco?
 - a. What cultivars are grown?
 - b. How large is the average farm size?
 - c. What is the production in kg/year/ha?
 - d. Where do farmers get their seed? (Import, own production)
 - e. How much fertilizer and pesticides are used? Are there many issues regarding soil fertility, potato diseases or environmental pollution?
 - f. Is the growth dependent on irrigation? If yes are their issues regarding water shortages and water pollution by cultivation?
 - g. Is anything known of the effect of potato production on biodiversity (land/water)?
2. What do you consider as the biggest challenge for the production of potatoes in Morocco?
3. What do you consider as the biggest issues for the sustainability of the production of potatoes in Morocco?

Transport/storage/ packaging



4. Can you elaborate on the process of storage, packaging and transport of harvested potatoes in Morocco?
 - a. Are there losses during transport and during storage? If yes, how much % do you estimate? What are the causes?
 - b. Do transport and packaging create much CO₂- production?
 - c. How is the packaging process undertaken? Does it create much waste?
 - d. Does the transport/ packaging and storage contribute to good jobs for people? What are their working conditions?
5. What do you consider as the biggest challenge for the transport and storage of potatoes in Morocco?

Food production and food processing



6. How much of the potatoes harvested in Marocco are processed? How much is retail?
7. Can you elaborate on the processing of potatoes in Marokko?
 - a. What products are processed and what are the end products?
 - b. Can you give some insight on the amounts (eventually varying per season)
 - c. What cultivars are preferred for processing?
 - d. Is there any information on the efficiency in terms of water and energy during processing?
 - e. How much jobs does the processing industry create? Do you know anything regarding the working conditions?

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8. What do you consider as your biggest challenge for the processing industry?
 9. What do you know about the market? Do you have insight in consumer preferences, retail prices, options for product diversification?

Questionnaire Ministry

1. Can you elaborate on the task of your Ministry in regards to the potato sector?
2. What do you consider as the biggest challenge for the potato sector?
3. What policy measure recently taken or announced by the Morocco government is relevant to the potato sector?
4. What are the policy measures in relation to production of potatoes in Morocco (extension/ investments)?
5. What are the policy measures in relation to water scarcity? Do you expect problems in the near future with respect to water availability?
6. What are the policy measures in relation to market for potatoes in Morocco (pricing, liberalisation)?
7. If the government could invest in technology for the potato sector, what would you do?
8. Is there anything you want to add to this interview?

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