

Technology Fact Sheet for Adaptation

G. Selection of adapted rootstocks and varieties ⁱ

Sector : Agriculture	
Subsector : All plant crops	
Technology characteristics	
Introduction	The selection of adapted rootstocks and cultivars relies on several technologies including biotechnology and plant breeding. - Biotechnology which is a high-tech involving in many cases the production of Genetically Modified Organisms (GMOs) is still prohibited in Lebanon. For this purpose, this technology will not be addressed. - Plant breeding relies on natural selection; cross pollination of different varieties (hybridization), natural mutation, and induced mutation through atomic manipulation, etc. No genes from other organisms are introduced.
Technology characteristics/highlights	- Plant breeding requires scientific research and field studies before releasing the new obtained breed to farmers for plantation on a commercial scale. - Plant breeding is conducted in research institutes and big nurseries, and requires lab and field experimentations as well as genetic resources conservation facilities (seed bank, mother plants orchard, etc.). - Varieties are tested for their characteristics for several years in trial plots. - Amongst the criteria of selection we mention: ✓ Fruit/ characteristics (flavor, color, caliber, maturity date, etc.) ✓ Plant characteristics (shape, vigor, type and date of blossom, etc.) ✓ Agriculture characteristics (yield, bearing year for trees, resistance/tolerance to pests and diseases, training and pruning type for trees, winter/summer crop for field crops, etc.) ✓ Environmental characteristics (tolerance/resistance to: different soil conditions, high/ low temperatures, chilling requirement, drought, etc.) - Vegetative propagation methods (cutting, grafting and tissue culture) enable technicians to sustain varieties mother plants characteristics and transmit them to other generations. However, propagation from descendants could diminish these characteristics.
Institutional and organizational requirements	Plant breeding involves lot of investments, hence most of the varieties are patented and breeders expect royalties for a define period of time. For this purpose, new varieties are copyrighted and protected by the international Union for the Protection of new Plant Varieties (UPOV). Countries who joined UPOV acknowledge the breeders achievement by granting them intellectual property right. So far, Lebanon is not a member of UPOV. Hence local varieties or varieties whether they are

	natural mutations or obtained from selection cannot be protected. Institutional amendments of our legislation are essential if such technologies should be initiated in Lebanon. Under the current situation, Lebanese farmers obtain patented plant varieties through local agents for international enterprises and nurseries. Nevertheless, these varieties are often pirated and propagated locally (especially for fruit crops). Eventual breeders and nurserymen as well as importing agents should be organized and put on one table to ensure property right and traceability. If the enabling environment is not ensured, plant breeding within the private sector cannot be real in Lebanon. Products from pirated varieties cannot be exported to countries member of UPOV. From the other hand many institutions (i.e. International research centers under CGIAR like ICARDA) produce patent-free varieties for most crops.
Operation and maintenance	Plant breeding requires substantial investments in skills, labor, equipments, money and time. Maintaining the varieties require the conservation of parents and varieties in seed banks or orchards. Only research institutions have the capacity to ensure operation and maintenance in Lebanon such as ICARDA, ACSAD, AUB and LARI. The introduction of imported varieties should be through their testing in experimental orchards belonging to the mentioned institutions, then at farmers' level with the collaboration of the importing agents.
Endorsement by experts	Biotechnology producing GMOs is not endorsed by all scientists and countries including Lebanon. Plant Breeding is recognized worldwide, however, acknowledgement of breeders should be illustrated by joining UPOV.
Adequacy for current climate	To ensure the adequacy of a new breed under current or future climate, it has to be tested into experimental plots in different climatic zones of Lebanon. Currently, cereals and legumes new varieties are provided and tested by ICARDA in collaboration with LARI.
Scale/Size of beneficiaries group	All farmers of Lebanon are concerned, namely those growing vulnerable crops (fruit trees, potato, tomato, cereals and legumes, etc.). However, the selection of the suitable cultivar or variety depends on the type of impact on the concerned crop for a specific bioclimatic zone.
Disadvantages	Plant breeding has no disadvantage by itself except the high investments required to deploy it, and the period of time to obtain new selected varieties. Importing new selections of cultivars (patented or not), then multiplying them locally is cheaper and less time consuming. Yet the replacement of local cultivars would result in a loss of agro-biodiversity for few crops, an increase in agriculture importation bills and an increase in investments for farmers.
Capital costs	
Cost to implement adaptation technology	Each variety or rootstock has a different price according to the species and the propagation technique, whether it is patented or not, produced locally or imported. If we take fruit tree seedlings, their price may range from 3.5\$ (local certified seedlings) to 20\$ (imported patented seedling).

	The cost per surface unit depends on plantation density which also varies with rootstock and species' varieties. Density may vary between 500 and 1700 trees/ha for apple and between 400 and 1000 trees/ha for cherry.
<u>Additional</u> cost to implement adaptation technology, compared to "business as usual"	Non-certified local seedlings are at 2\$. If replaced by adapted rootstocks and varieties, the additional cost may vary between 1.5 and 18\$/seedling. For the same density of 500 trees/ha, the additional cost will be 750 to 9000\$/ha. If the density is increased to 1000 trees/ha, the additional cost will double.
Long term cost (i.e. 10, 30, or 50 years) without adaptation	The tree shelf live is 50 years, which means a minimal breakdown investment. Nevertheless, annual costs for training and pruning are high. Yields are lower under climate uncertainty.
Long term cost (i.e. 10, 30, or 50 years) with adaptation	The shelf live is 20-40 years, breakdown is significantly higher. Annual costs are either the same or lower. Yields are high.
Development impacts, direct and indirect benefits	
Direct benefits	- Increase the production and quality of the field crops (at least by 20%), and an early bearing of fruit tree crops, when using selected rootstocks (2-4 years gain). Production is maintained along years, and is homogenous among orchard. - An additional cropping season is possible for field crops if suitable cultivars are used (case of potato in the Bekaa...). - Losses due to climatic adverse and insect outbreaks are decreased (gain in quality). We estimate that the profit of the farmer would increase on the run, when compared to baseline scenario (example wheat or tomato). - For apple in a full production orchard, the benefit can be 10000\$/ha higher by using selected rootstocks and varieties than in traditional orchards.
Reduction of vulnerability to climate change, indirect	- Selecting specific rootstocks would increase drought tolerance, thus reduce water consumption by plants. - Certain rootstocks and varieties are tolerant to spring frost or heat and can be recommended to vulnerable regions like the Bekaa. - Some varieties have low chilling requirements, resistant to cracking due to rain or excessive drought, resistant to sunburn... - Some rootstocks/varieties induce a change in blossom or harvesting period which might be interesting for some crops under specific conditions. - Some varieties have longer or shorter vegetative period which enables the farmers to adjust their planting/harvesting period according to climate. - Some rootstocks and varieties are resistant or tolerant to pests and diseases that might merge under future climate. They can be a mean to reduce these outbreaks without relying on pesticides for concerned crops. - The disposal of larger range of varieties and rootstocks would increase the farmer's choice and consequently the resilience to climate change.

Economic benefits, indirect Employment Growth & Investment	Job opportunities would increase especially at the technical level within the service providers' enterprises, nurseries, labor force, as well as within the research institutes if the introduced varieties are to be tested before releasing them to the market. Capital requirements are essential at research institutes, nurseries, and farmer's level. An increased production of selected plant material is reflected in an increased economic growth.
Social benefits, indirect Income Education Health	The income of farmers increases. Farmers' capacity to manage their production and adapt to climate change (resilience) through training is higher. The use of varieties resistant/tolerant to pests and diseases is reflected in lower pesticide residues in plants, which has a positive impact on health.
Environmental benefits, indirect	Reduction in chemical pollutants (pesticides), reduction of water consumption when varieties tolerant to drought are used.
Local context	
Opportunities and Barriers	Selection of adapted rootstocks and cultivars is an opportunity to renew old fruit orchards which are suffering from pest and diseases and a lower quality and quantity of production. It is also opportunities to introduce new varieties demanded both on local and international markets to diversify and widen the period of production for a better resilience to climate change. It has also an opportunity to develop in higher or lower altitudes under future climatic conditions, according to water and chilling requirements of the variety, blossom and harvesting dates and its vegetative period length. The higher initial cost to develop these technologies and the absence of a sound crediting system for farmers or nurseries, as well as the absence of skills and expertise and the enabling environment for the protection of property right are the major barriers for their development. Another problem is the lack of expertise and research staff within the research institutes (i.e. LARI, CNRS, AUB...) not only to conduct plant breeding, but also to test varieties and reproduce them locally. The dissemination of new varieties should be carried out along with extension service to obtained the required results.
Market potential	There is an increasing trend for renewing fruit orchards by using selected varieties and cultivars in Lebanon. The same trend is shown for cereals and legumes and some vegetables. Although potato is a major crop with a higher economical value, the market is focused on one variety, and precautions should be considered before introducing new varieties.
Status	Besides the work of ICARDA and LARI, no plant breeding program exists under the current conditions. The Ministry of Agriculture with LARI in collaboration with nurseries has initiated a certification system to obtain seedlings free from disease. Several private enterprises are introducing new cultivars to Lebanon. As for cereals and legumes, the Ministry of Agriculture in collaboration

		with ICARDA and LARI has started to reproduce new varieties for further dissemination to farmers.
Timeframe		Medium to Long Term.
Acceptability to local stakeholders		Most farmers are unable to adopt new selected rootstocks and varieties if left alone due to socio-economical constraints and to their lack of knowledge. The GMOs are not socially accepted yet, while new plant varieties are not easily welcomed due to the farmer's fear from market constraints, the need to adapt their practices and inputs according to the new varieties. Cereals and legumes are easier to disseminate and accepted by farmers, as they are subject to governmental direct or indirect subvention. The major problem is for potato, since the major exporters, or seed importers are the current driving force of the market, and are the key players in this market chain. Awareness raising for these stakeholders is a milestone.

ⁱ This fact sheet has been extracted from TNA Report – Technology Needs Assessment Reports For Climate Change Adaptation – Lebanon. You can access the complete report from the TNA project website <http://tech-action.org/>