The Geopolitics of Saffron and the Puzzles of Saffron Arithmetic

Richard Warren Shepro

Abstract: Spanish saffron from La Mancha commands the highest prices in the world, but Iran produces over 90% of the world's saffron. Spain today is considered the world's second largest exporter of saffron solely because it imports nearly half of the world's production – purchased from Iran – which exporters in Spain then channel to the rest of the world as a Spanish product. Does this tell us that saffron is really a commodity? Or is there a reason for saffron from certain places to be highly prized and priced accordingly? The statistical puzzles of saffron arithmetic lead us to broader questions relevant throughout the food world, such as: what makes a food from a particular place so special that governments should reward its makers with a special designation or monopoly?

Saffron is vital to the cooking of the Middle East and parts of South Asia. In Europe and North Africa, it is essential: in *paella* in Spain, and key to important dishes in Italy (*risotto Milanese, chiusoni* ...), France (*bouillabaisse, mouclade* ...) and in North Africa (many couscous dishes and *tagines* ...). Although the extreme medieval taste for spices other than pepper largely disappeared from European food in the seventeenth century,[1] saffron remained significant, a status that has continued to this day.

Where does saffron come from? Botanically, the answer is clear. Saffron comes from the female reproductive organ (pistil) of a lovely purple autumn flower, *Crocus sativus,* the saffron crocus. Each bloom's pistil contains three stigmas (pollen receptors) which are attached to the style, the stalk that connects the stigmas to the ovary. The stigmas are red, the style is whitish or yellow. (See Figure 1.) Saffron filaments, or threads, are the dried stigmas. They can be sold as separate threads, or with the three stigmas still attached to a part of the style, which some say adds complexity to the flavour,[2] although nowadays most premium saffron contains almost exclusively red threads.

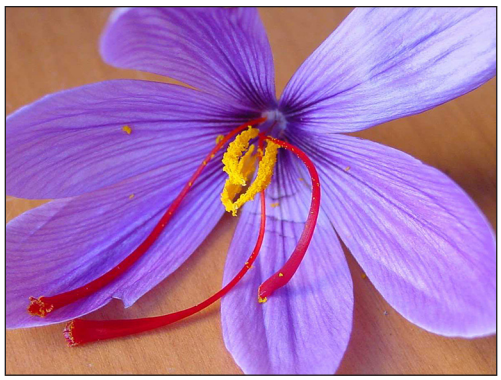

Figure 1. Saffron crocus, La Mancha, Spain. Photograph: Azafrán de la Mancha.

Geographically, the answer is like the solution to a puzzle. In 1986, it was

reported that Spain 'satisfies 70% of the world's demand for saffron.'[3] Two decades later, Iran produced over 90% of the world's saffron.[4] It is natural to wonder how such a momentous shift could happen, particularly at a time when Iran's role in international commerce has been so restricted by boycotts and sanctions. Certainly, as Spain has emerged from its economic isolation under the long regime of Generalísimo Francisco Franco, there been a shift away from agricultural products, but not nearly enough to cause a shift of this magnitude. On the contrary, new agricultural cooperatives have been established in Spain, there is government promotion of saffron from La Mancha as the finest saffron in the world, and in 2001 the European Union awarded its coveted 'Protected Designation of Origin' (PDO)[5] status (like that for *Reggiano Parmigiano* cheese and for Champagne) to Spanish saffron grown in La Mancha that meets certain standards.[6] (See Figure 2 and Figure 3.)

FIGURE 2. Saffron and discarded crocus petals, La Mancha, Spain. Photograph: Azafrán de la Mancha.

This specially designated La Mancha saffron appears to command the highest saffron prices in the world.[7] Even generic saffron is incessantly referred to as the most expensive spice[8] in the world. In cost per kilogram that is an accurate statement but in terms of cooking expense it is an arithmetic myth. A miniscule quantity can flavour a lot of food or liquid. Many cooks, conscious of its cost but also mindful that too much saffron can make a dish bitter, count out each saffron thread and as a rule of thumb employ five or six threads for each person their dish will serve (one gram of saffron generally contains from 160 to more than 400 filaments).[9] Others, with accurate scales, suggest 0.02 grams per serving. Even considering the high cost of purchasing tiny quantities of a spice in a supermarket those proportions amount to only about 15-40 Eurocents per serving, far less if the saffron is purchased in larger quantities, and one well known merchant suggests the cost would be only 0.4 cents

FIGURE 3. Official European Union PDO Quality Label.

per serving if only people would steep their saffron long enough in liquid to release the full flavour. One could bankrupt oneself on a surfeit of fresh truffles or caviar because they are foods, not flavourings; that would be hard to do with saffron.

The far greater arithmetic puzzle is found in the saffron production and sales numbers released by economic reporting agencies. The compilation and analysis of international trade statistics is fraught with difficulties of comparing different reporting systems and levels of accuracy and honesty, and is far from an exact science. However, all variations of the relevant statistics reveal that Iran is indeed the producer of almost all the world's saffron, that about half of Iran's saffron is exported to Spain (dwarfing Spain's own production) and, astonishingly, that the total amount of saffron that Spain exports is about the same as what it imports from Iran.[10] To explain this a different way: according to the Ministry of Industry of Spain, in 2010 Spain produced only 1,500 kilos of saffron, but almost 190,000 kilos were exported from Spain and labelled in some way as Spanish.[11] In many years the sum of the reported saffron exports attributed to Iran and to Spain significantly exceeds the total world production.

The inescapable conclusion is that Spain today is considered the world's second largest exporter of saffron solely because it reexports nearly half of the world's saffron, purchased from Iran – which exporters in Spain then channel to the rest of the world as a Spanish product. The trade statistics are not corrected for double counting: the same saffron is counted as an Iranian export when it leaves Iran, and again when it leaves Spain. Iranian saffron is repackaged, relabelled and reexported as 'packaged in Spain', 'selected and packed in Spain,' or sometimes even 'produced in Spain'. Trading saffron through Spain allows Iranian producers to achieve higher prices for their goods and at the same time to minimize the effects of boycotts and sanctions – sometimes through legal means and often not.

Medieval trade routes and Muslim expansion led to a taste for saffron in the foods of Spain and Italy, and the Crusades and maritime routes took it to England and France. The spread of saffron throughout the world was fast and vivid, like the spread of the saffron's evocative colour when it is submerged in a warm liquid. The expansion was not simply in terms of use, as with most spices that came from exotic lands, but in cultivation as well. Other costly imported spices required special growing conditions not found in Europe, but *Crocus sativus* can grow in any temperate climate. Cultivation in Britain became significant enough that by the 1540s the market town in Essex known as Magna Walden and Chipping Walden had changed its name to Saffron Walden, with saffron the chief crop sold.[12] Plans were laid for cultivation of saffron in Ireland.[13] It became an important crop in France, and was grown in North America.

For some reason, over subsequent centuries saffron production has essentially retreated to the locations where it was grown in the early middle ages: Spain, Kashmir and, overwhelmingly, Iran. By 2005, Iran was producing 94% of the world's saffron, exporting 82% of the world's supply and consuming 12%, and this market share has continued.

There has been some expansion to new areas as well, but none significant in terms of world production.[14] It can be easy for the high price of saffron to lead people to expect easy money is to be had, forgetting the labour and distribution costs of production and the difficulty of scaling production to compete effectively. A recent thoughtful plan to grow saffron in Rhode Island, the smallest US state, is intriguing but the promise that growing saffron 'means that farmers in the Northeast stand to make a lot of money'[15] is far from assured.

Labelling

Knowing where saffron comes from depends, in the first instance, on labels. Food labelling laws generally have three principal goals. First, there is a public health component. This was the original impetus for many purity laws throughout the world, to protect the public from adulterated, dangerous or even poisonous products. The best saffron is sold in filaments, each filament a stigma, and even with less expensive ground saffron where adulteration is more plausible but appears to be rare, there is rarely a public health concern. At a broader level, accurate labelling protects the consumer. Labels should be honest and not mislead people. Finally, following the *Reggiano Parmigiano* - Champagne model, there is the protection of the growers or producers of products that have achieved a special reputation for goodness or quality that also protects consumers who know that they want, for example, the highly prized French *lentilles de Puy* and not just a generic green French lentil.

Labelling laws and regulations for food are exceedingly complex, often involving multiple and sometimes overlapping regulatory schemes. Where international trade is involved, they become even more complex, often involving treaties and arcane principles of international law. Much of the Iranian 'Spanish' saffron winds up in the United States, which is the largest consumer of saffron but technically only the third largest importer of saffron (after Spain, by far the largest, and then Hong Kong which, like Spain but on a smaller scale, 'exports' most of what it 'imports', probably for similar reasons but without a historical connection to saffron production). The US has an array of laws and regulations that create a scheme known as 'COOL': Country of Origin Labelling regulations. These rules have many peculiarities[16] but, viewed through all the regulations, there is currently no US legal requirement for a reseller to disclose to end users the country of origin of a spice. US customs regulations do require declaration of the country of origin of products imported for commercial purposes, but after importation no rule requires that information as to spices to be repeated. In the end, in the US, if a spice is marked as having come from a particular country it is done either for marketing reasons or by a merchant who simply feels it is important for customers to know.

Much of this remarketing may have been legal under EU law. There are many details and exceptions ('loopholes') in the law of labelling of agricultural commodities, and as a practical matter traceability of origin can be difficult. Careful phrasing such as 'packed in Spain' may

be accurate even if designed to mislead. Sales in the US are generally not subject to EU law.[17] US customs regulations do require declaration of the country of origin of products imported for commercial purposes, but no rule requires that, for spices, information as to origin be repeated after the spices have passed through customs. It was formerly legal in the EU for sales simply to identify the name of a Spanish shipping company on labels, regardless of where an agricultural product came from. However, national legislation in Spain has been revised to address labelling, and EU labelling continues to evolve.[18] It is more complicated now, and it can take some time for enforcement to keep up with legal changes. Finally, it is worth remembering that although the prices are high the volume of saffron sales worldwide is small and may only rarely attract the attention of law enforcement officials.

The sale of so much Iranian saffron through rebranding in Spain is not simply a matter of getting a higher price because of the prestige of Spanish saffron. It is also a way for Iranian producers to sell saffron during a time when transparent exports from Iran are politically difficult, especially if the goal is to sell the saffron in the United States. The United States has imposed forms of trade sanctions on Iran at various times since 1979, lifting them under the Joint Comprehensive Plan of Action ('Iran Nuclear deal') in 2015. At that moment, Iran appeared poised to rejoin the community of nations.[19] With the chaos that ensued after the United States withdrew from this agreement in 2018 and reimposed a complete ban on Iranian imports, the export potential for overt Iranian exports changed yet again. With a treaty still in force with Europe, but unilateral sanctions imposed by the United States, Iranian producers face difficult decisions and continue to come up with 'creative' solutions. United Nations trade sanctions on Iran have always been less severe and do not affect saffron. Spain (despite recent US opposition) has bilateral trade agreements with Iran. Saffron marked as coming from Iran does not appear to be sold in the United States, although some products are labelled as 'Persian saffron.' Despite Iran's dominant world position in saffron production, the saffron trade is miniscule compared to Iran's oil and other industries so the saffron trade has not figured in trade negotiations. However, it is implausible that the US could import as much saffron as it does without most of it coming indirectly from Iran.

An additional connection between Spain and Iran in the saffron market is that Spanish businesses have invested in production in Iran, and introduced more modern technology, particularly controlled drying at low temperatures as is done in La Mancha.[20]

Saffron Quality and Protected Designations

Saffron quality can be measured. There are quality standards, different from country to country, but all based mainly on measurable attributes such as the length of threads, the depth of the colour, the power to colour a liquid. Spain sorts its saffron into four categories based on colouring power: the top is coupe (all stigmas cut from the style so that everything

is red), then Mancha (still high quality), and finally Rio and Sierra (more brownish than red). The Iranian system categorizes saffron in a different way, with Sargol (all red, but sometimes just the tips of the filaments), Nigin (all red, longer filaments, often called neguine, using a French version of the word because France has significant bilateral trade with Iran), Super Nigin (still longer filaments, the most expensive), Pushal (similar to Mancha, with the three stigma still attached to the style) and lower grades that include large amounts of style.

A more recent approach to grading is laboratory analysis based on an ISO standard promulgated[21] that sets minimum measurement levels for a number of characteristics, mainly for three chemical components: picrocrocin (flavour and bitterness), crocin (colour) and safranal (aroma). Many saffron producers advertise based on these ISO measurements, particularly the measurement for colouring power.

Separate from these ratings are the official geographical recognitions--the PDOs – and other governmental support, and Spanish saffron from La Mancha is not the only saffron in the EU to achieve such a recognition. There is now a separate PDO for safran from Munder, in Switzerland, and for Krokos Kozanis, in Greece. To achieve these recognitions, Switzerland and Greece had to demonstrate to the EU that there was something unique about them. Other saffron is highly prized, and two venues – Kashmir, an ancient venue, and Afghanistan, a new one – deserve special attention:

Saffron from Kashmir has been famous from antiquity, but achieved its own protected legal status in May 2020.[22] (See Figure 4.) This is not the PDO received from the EU by Spain, Switzerland and Greece, but something granted by the government of India, which has a legal status outside India only to the extent it is protected by international agreement with countries that want to share protection of such designations with India.[23] The impetus for Kashmiri producers to seek protected status seems to have been that the price of Kashmiri saffron had fallen by nearly 50% as Iranian saffron became dominant.[24] This status was achieved a few years after a professor of marketing studies in Kashmir published a paper in a management studies journal arguing that the crisis in the Kashmir saffron industry would be best addressed by developing a better 'branding strategy,' emphasizing high quality, providing employment for women, and cracking down on Iranian saffron being sold as Kashmiri, a 'spurious trade [that] runs in crores.'[25] (See Figure 5.)

FIGURE 4. Saffron crocuses in Kashmir, India. Photograph: Kashmir Kesar Kingdom Pvt. Ltd.

FIGURE 5. Saffron harvest, Mashad, Iran. Much traditional harvesting is done by women. Photograph: David Vanille/Sélection d'épices

Afghanistan has become, fairly suddenly, the third largest exporter of saffron, which means that it is actually the second largest producer since Spain's production is so small.[26] Its nascent industry has achieved high quality, is charging very high prices and its distributors have produced beautiful marketing campaigns based in part on the noble idea that saffron will help the country overcome its dependence on opium production – a tall order indeed: Afghanistan is to the opium market what Iran is to saffron, generally thought to produce 90% of the world's supply, but U.N. estimates suggest opium to be a $4 billion market while saffron production worldwide is $390 million.[27]

ISO laboratory analysis and an emphasis on geographical origin are in some ways antithetical to each other. The ISO parameters are based on the idea that it is possible to tell quality by measuring the strength of certain components. ISO analysis does not address origin, and some well-respected merchants assert it is more objective because of that and never identify the source of their saffron. Although some geographical designations require quality measurements to be met, the awards based on geography depend more on history, *terroir,* and perceptions of quality developed over centuries. The two ideas are starting to converge in a new field of 'food authenticity testing' that use spectroscopy and related statistical analysis to confirm geographical origin and detect fraud. These have been used to analyze the origin of wine, olive oil, coffee[28] and these digital-fingerprint techniques have entered the world of saffron evaluation.[29] So far, analysis of this sort has consistently verified the authenticity of La Mancha PDO saffron and also confirmed that much that is simply labelled as 'Spanish' or 'Packed in Spain' is not.[30]

Conclusion

The statistical puzzles of saffron arithmetic and the subterfuge it reveals lead us to broader questions that are also relevant throughout the food world. What makes an agricultural product grown in a certain place so special that we should take special note of it? Should governments reward the makers or growers of such products with a special designation that increases their profits and gives them a sort of monopoly? If so, do we do so in the name of gastronomy, or in service of a public that craves information? And are these questions of quality genuine, or are

they the subject of lore? Can the quality be measured, as the ISO ratings suggest, or is the issue so complex that it can only be sensed in a kind of connoisseur's gestalt?

On the other hand, are some products, even if rare and precious, really commodities, where once a certain level of quality is achieved most specimens are roughly the same and there is no need for anyone to be a connoisseur?

With regard solely to saffron, does the massive mislabelling without a corresponding consumer revolt tell us that saffron is really a commodity? Are the proponents of pure ISO testing and an indifference to geographical origin correct? Is there still a reason for La Mancha saffron to cost twice the price of the next 'best'?

In the world of cheese, or wine, there are specially protected products whose distinctiveness is evident, and these products deserve special appreciation and attention. No one would confuse *Parmigiano-Reggiano* with *Comté* cheese. On the other hand, both of those cheeses have competitors that in a blind tasting could easily be confused: a young *Parmigiano-Reggiano* with an older *Grana Padana*, for example, or *Comté* with *Gruyère*. In the wine world, there have been tests and criticisms of whether connoisseurship is real.[31] With an ingredient such as saffron that is cooked with many other ingredients, is it possible that anyone can really tell whether best quality La Mancha saffron PDO has been used in a paella or whether the dish is 'adulterated' with an equally famous saffron from Kashmir, or with a carefully selected Iranian saffron that is marketed only as saffron 'packed in Spain'?

The answer as to saffron is that the peculiar trade in saffron provides a peculiar and probably beneficial form of consumer choice, although outright mislabelling should not be allowed. A connoisseur can buy saffron based on pedigree and geographical assurance (PDO), or buy it with no indication of origin from a merchant who stakes his reputation on an ISO certificate. Part of the magic of saffron, perhaps, is that the fragrance and colour it imparts when skilfully used can blend with together with memories and a sense of history and geography. Saffron from a special place can create an unforgettable experience, but other saffron may also, quite apart from the question of where it came from. Pondering the ancient history of saffron and the fluid world-wide movement of both spices and people in our modern world, I am particularly struck by the endorsement of Iranian saffron in this portion of the 2019 poem[32], 'Saffron,' by a young American poet and biologist of Iranian descent, Amir Safi:

> My mother picks up the pestle and mortar and does to saffron what the clerics have done to her country/pours in steaming water till the liquid in the bowl becomes the Caspian swallowing the sun/it smells like a home I have not returned to in 10 years/saffron/pound for pound/the most expensive spice in the world/worth more in its weight than gold/if customs found it, they would surely throw it away/but my grandmother is a high-stakes smuggler/ her currency is my mother's joy/every time she visits, she brings some in her luggage/and my grandmother always comes through/and … approaches me

> with the same enthusiasm I had as a boy catching a fish/holds the small packet between her thumb and her index finger and says/you cannot find saffron this good in America, Amir/you cannot find saffron like this anywhere, but Iran/and this is where I learn the limitations of the American dream/that you cannot find here what you already have ...

And the same could be said of saffron from La Mancha, or Kashmir, or perhaps even, if the circumstances are right, threads of Iranian saffron taken from a little tin covered with pictures of nineteenth-century rural Spain and the carefully chosen words 'Genuine Pure Saffron' and 'specially selected and packed in Spain', surrounded by a saffron-coloured cellophane wrapper to which (perhaps after customs has been cleared) someone has affixed a small official-looking seal that says 'Genuine Spanish Saffron'.

Notes

1. See Paul Freedman, *Out of the East: Spices and the Medieval Imagination* (New Haven: Yale University Press 2008), particularly 'Classic French Cuisine and the End of the Reign of Spices,' pp. 216-223.
2. John Humphries, The Essential Saffron Companion (Berkeley: Ten Speed Press 1996) p. 29.
3. Susan Linee, 'A Pound of Saffron is Worth a Bounty: In Spain, Growing This Expensive Spice Helps Maintain a Good Life,' *Los Angeles Times,* Nov. 23, 1986.
4. M. Ghorbani, 'The Efficiency of Saffron's Marketing Channel in Iran,' *World Applied Sciences Journal* 4 (2008).
5. The PDO designation has a different name in each of the 23 EU languages, so it is known as DOP in central Spain (Denominación de Origen Protegida) and in Italy (Denominazione di origine protetta); AOP in France (Appellation d'origine protégée) (AOP); and g.U. in Germany (Geschützte Ursprungsbezeichnung). The PDO is the most rigorous of the EU food classification schemes: https://ec.europa.eu/info/food-farming-fisheries/food-safety-and-quality/certification/quality-labels/quality-schemes-explained_en The term PDO is also used to refer more generally to include similar schemes around the world.
6. The history and progress of the appellation is well set out in the website of the foundation that administers the mark *Azafrán de la Mancha,* and provides information on the 19 packagers that are officially allowed to use the designation. https://doazafrandelamancha.com/en/pdo-management.html#timeline
7. At wholesale pricing. The highest-priced saffron in the world may be the generic saffron powder sold in tiny amounts in envelopes. In the US these can cost $8 for three 120 mg portions (about $20,500 per kilo). It's better to buy a full gram of good quality saffron filaments for about the same $8 ($8,000 per kilo). One gram of fully certified La Mancha saffron of the highest quality can be had for $18 ($18,000 per kilo). Because packaging is a large part of the cost in small quantities that same La Mancha saffron sells for $10,000 per kilo in a somewhat larger tin).
8. Saffron is generally considered a spice but occasionally an herb.
9. Claudia Roden notes this practice in *The Food of Spain* (London: HarperCollins 2011) though with her long experience prefers to rely on 'a pinch.'
10. Except as otherwise cited, the statistics I have relied on are compiled by U.N. agencies and able to be analyzed and presented in different ways with the assistance of statistical databases such as statista.com. As of this writing, the latest compiled statistics are for 2017. There is more limited compiled data for 2018.
11. https://elpais.com/diario/2011/01/30/sociedad/1296342004_850215.html
12. The name remains today, although saffron is no longer grown there. A detailed history is contained in the 1836 book, Braybrooke, Richard Griffin (Baron), *The history of Audley End. To which are appended notices of the town and parish of Saffron Walden in the county of Essex* (London: S. Bentley 1836).
13. Anonymous, *An account of saffron the manner of its culture and saving for use, with the advantages it will be of to this kingdom* (Dublin: A. Rhames 1732).
14. There are revivals of production in parts of France, in the United States, in Greece and other areas.

15. 'Saffron is the world's most expensive spice. Why don't we grow it ourselves?' https://thecounter.org/saffron-northeast-university-of-rhode-island-iran/
16. For example, butchers and fish markets are not required to reveal the country of origin of their meat or fish, but full line grocers are.
17. Occasionally there are special agreements with the United States, such as the agreement that the US will not allow sparkling wine producers to use the term 'Champagne' unless they had a pre-existing use.
18. 'Los análisis confirman el fraude del azafrán,' *Levante* (19 January 2016) https://www.levante-emv.com/sociedad/2016/01/19/fraude-azafran/1368027.html
19. Naomi Duguid's 2016 book, *Taste of Persia: A Cook's Travels Through Armenia, Azerbaijan, Georgia, Iran and Kurdistan* (New York: Artisan), reflects the optimism of that time and depicts visually and in words an exciting quest to find saffron fields near Mashad, in eastern Iran, where most of Iran's saffron is produced.
20. Lukas Huss, 'The Case Study of Saffron from La Mancha PDO' (*Current Issues of Protected Geographical Indications 2016*) p. 11.
21. International Organization for Standardization, Standards ISO 3632-1 (2011) and ISO 3632-2 (2010) which replaced earlier standards from 1980 and 1993. See https://www.iso.org/obp/ui/#iso:std:iso:3632:-1:ed-2:v1:en and https://www.iso.org/standard/44526.html
22. 'Kashmiri Saffron given GI Tag: Know what is Geographical Indication (GI) Tag?' https://www.jagranjosh.com/general-knowledge/what-is-the-meaning-of-geographical-indication-tag-to-kashmiri-saffron-1588680149-1
23. There is some international protection through the membership of the World Trade Organization, which hotly debates the details of geographical name protection but does not have the power the EU has over its member states. See, for example, the example of basmati rice, in Estelle Biénabe and Delphine Marie-Vivien, 'Institutionalizing Geographical Indications in Southern Countries: Lessons Learned from Basmati and Rooibos,' 98 *World Development* (October 2017), pp. 58-67 https://doi.org/10.1016/j.worlddev.2015.04.004 . Outside the EU, geographical name protection quickly gets far weaker but even more complicated than within the EU. The Lisbon Agreement of 1958 has few signatories. A newer initiative, the 2015 Geneva Act of the Lisbon Agreement, has even fewer. The protections it provides are administered by the World Intellectual Property Organisation (WIPO) in Geneva. The EU and a few other countries, including North Korea, joined the Geneva Act group in February 2020. The US opposes the process.
24. 'Kashimiri Saffron Gets GI Tag,' (Agriculture World of India, 2 May 2020) https://krishijagran.com/agriculture-world/kashmiri-saffron-gets-gi-tag/
25. Quite aside from saffron arithmetic, there is a fascinating quality to the traditional Indian numbering system under which a 'lakh' is one hundred thousand and written as 1,00,000 and a 'crore' is one hundred lakhs, written as 100,00,000. The article is: Natasha Saqib, 'Geographic Indication as a Branding Tool for Saffron', 1 International Journal of Management and Social Science Research Review 11 (May 2015) and the crore comment appears on p. 22.
26. For 2017, exports in US dollars were Iran $114 million, Spain $63 million, Afghanistan $18 million, but Spain's imports totalled $55 million while Iran's and Afghanistan's imports were insignificant.
27. See, for example, Stephanie Glinsky, 'Afghanistan: Herat's opium fields make way for saffron: Afghanistan's 'red gold' offers an alternative to a crop some Afghan farmers despise,' The National, July 4, 2019 https://www.thenational.ae/world/asia/afghanistan-herat-s-opium-fields-make-way-for-saffron-1.882342 and Mujib Mashal, 'Hashim Aslami Has Just One Word for Afghan Farmers: Saffron,' *The New York Times,* 26 April 2019.
28. M.J. Martelo-Vidal and M. Vázquez, 'Advances in Ultraviolet and Visible Light Spectroscopy for Food Authenticity Testing,' in *Advances in Food Authenticity Testing* (2016) Section 3.3.1.
29. Josep Rubert et al., 'Saffron authentication based on liquid chromatography high resolution tandem mass spectrometry and multivariate data analysis,' 204 *Food Chemistry* 201 (2016) https://www.sciencedirect.com/science/article/abs/pii/S0308814616300048. See also R. Consonni et al., 'NMR Spectroscopic Studies in Saffron Authenticity and Quality,' in *Magnetic Resonance in Food Science: Defining Food by Magnetic Resonance* (London: The Royal Society of Chemistry 2015) pp. 65-76.
30. Rubert et al. From time to time there are also reports of adulteration involving substitution of parts of the crocus that are not saffron, or stigma from other flowers, particularly with powdered saffron where other substances can be easier to disguise as actual saffron powder.

31. See, for example, the statistical study by Prof. Roman Weil, 'Analysis of Reserve and Regular Bottlings: Why Pay for a Difference Only the Critics Claim to Notice?' 18 *Chance*, Number 3 (Summer 2005) and the famous statistics article by Prof. Orley Ashenfelter, 'Predicting the Quality and Prices of Bordeaux Wines' 118 *The Economic Journal* 529 (1 June 2008). http://media.terry.uga.edu/documents/economics/ashenfelter_predicting_quality.pdf
32. Michigan Quarterly Review (April 15, 2019) https://sites.lsa.umich.edu/mqr/2019/04/saffron/