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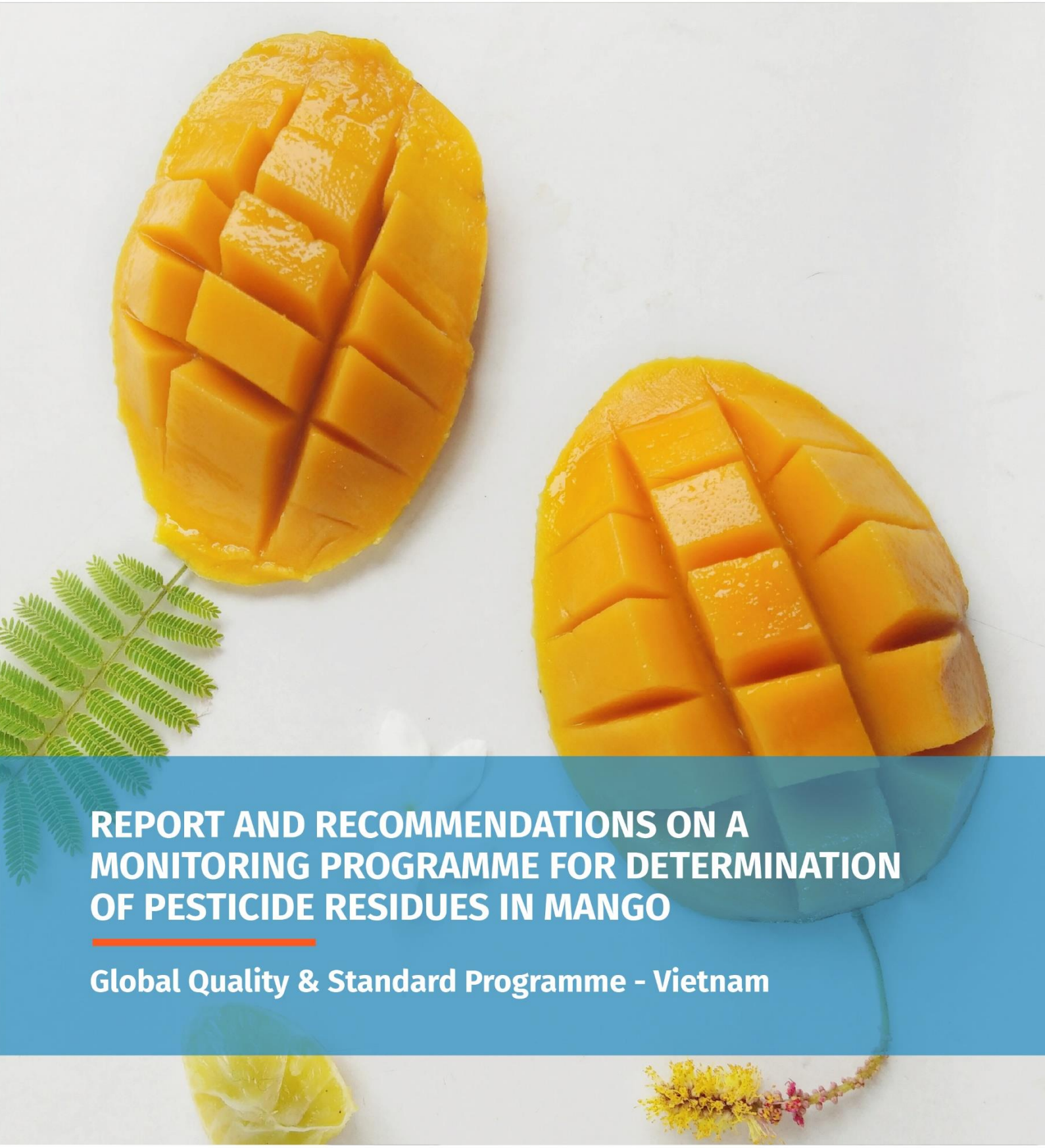

REPORT AND RECOMMENDATIONS ON A MONITORING PROGRAMME FOR DETERMINATION OF PESTICIDE RESIDUES IN MANGO

Global Quality & Standard Programme - Vietnam

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DISCLAIMER

Table of Contents

Abbreviations

ASEAN	Association of South Asian Countries
DARD	(Provincial) Department of Agriculture
EFSA	European Food Safety Authority
EN	European Standards
EU	European Union
FAO	Food and Agriculture Organization
GAP	Good Agriculture Practice
GQSP	Global Quality and Standards Programme
HCMC	Ho Chi Minh City
ISO	International Organization for Standardization
LOD	Limit of Detection
LOQ	Limit of Quantification
MARD	Ministry of Agriculture and Rural Development
MoH	Ministry of Health
MRLs	Maximum Residue Limits, mg/kg
NAFIQAD	National Agro Forestry Fisheries Quality Assurance Department
PE	Polyethylene
PHI	Pre-harvest interval
PPD	Plant Protection Department
RASFF	Rapid Alarm System for Food and Feed (operated by the EU)
SE	South-East
TCVN	National Standards
USA	United States of America
VND	Vietnamese Dong

Highlights

- Vietnam has never designed and applied a scientifically structured (i.e. risk-based) sampling and testing exercise to determine the nature and extent of non-compliance of pesticide residues in fruits and vegetables.
- As a result Vietnam was not able to provide any information to a recent FAO study of the status of residue monitoring in the SE Asian region.
- Monitoring data can trigger advisory actions for proper use of pesticides, and it may also be used for dietary exposure to pesticide residues and risk assessment of consumers.
- To obtain reliable information representative samples must be taken applying preferably stratified random sampling scheme.
- The principles of planning monitoring programme for mango, as set out in this document, can, and should, be applied for other commodities and for the whole country.
- Violative results identified by the monitoring should be subject to rigorous follow-up, to identify root causes, with subsequent adjustment to the risk management approach to reduce or eliminate such occurrences in future.
- The laboratories should expand the scope of their test methods and verify their performance for at least those residues which are to be looked for in the samples.

1. Executive Summary

This report is produced by the Global Quality and Standards Programme (GQSP) in Vietnam: “Increasing quality and standards compliance capacity of Mango value chain in Mekong River Delta”. It sets out a reasoned approach to the design of a residue monitoring programme for the determination of pesticide residues in general and specifically in mango.

The objective of a pesticide residue monitoring programme is to provide information on the distribution of residues in various agricultural commodities, compliance of residue levels with legal limits and practical applicability of use conditions specified in the registration documents concerning residue levels in harvested crops. In addition, the monitoring data can trigger advisory actions for proper use of pesticides and may also be used for calculating the dietary exposure of consumers to pesticide residues and for subsequent risk assessment.

In general the sampling target should cover a well-defined spatial area (the whole country or a specified part of it) and all objects to be sampled should be accounted for and accessible. To obtain reliable information to fulfil the objectives of monitoring programmes representative samples must be taken. In view of the large heterogeneity of the objects within the sampling target, ideally stratified random sampling design should be used provided that sufficient information is available for its application. However, if this is not the case, simple random sampling (without replacement) with equal probability of the selection of the elements of the sampled population is the method of choice.

In the specific case of the recommended model monitoring programme for mango proposed by

the GQSP Project in Vietnam, samples of two major varieties (Cat Chu and Cat Hoa Loc) should be collected by authorized specialists responsible for sampling (whether from DARD in relevant provinces or NAFIQAD) from the available mango fruits in the packing houses, wholesale markets and exporters' warehouses located in Ho Chi Minh City (HCMC), Tian Giang and Dong Thap Provinces along the main harvest seasons. The selection of specific sampling locations and sequence of sampling should be finalised based on the final decision on implementation of the pilot monitoring programme.

The number of samples to be taken has been calculated based on binomial principle which does not assume any parametric distribution but enables the risk manager to select the desired percentage of the residue population with specified probability. It is emphasised that the selection of these parameters is the exclusive task of risk managers. There is no clear-cut level which could be used as reference.

Nevertheless, it is recommended to take 114 samples from both varieties along the main harvesting season. That would enable detecting compliance of 98% of the mango production with 90% probability. However, if the funds are available and the available laboratory testing capacity permits random sampling may be increased to 149 lots from each variety. This would provide ≥98% of residue distribution should be determined with 95% probability.

Sampling should be performed in line with the Sampling Guidelines published by the Codex Alimentarius.

The laboratories should apply the appropriate variants of International Organization for Standardization (ISO) and European Standards (EN) standard QuEChERS methods.

Provided that these methods have already been fully validated to prepare for the accreditation by Bureau of Accreditation, and in the absence of any other data on probability and nature of non-compliance it is acceptable to test and verify only their performance for a) active ingredients of pesticides authorized for use in mango in Vietnam (Appendices 2, 3), and b) the violative residues reported in the EU Rapid Alarm System for Food and Feed (RASFF) notifications (Appendix 4). The limit of detection should be targeted as shown in Appendices 5 and 6. Special attention is also recommended to be paid to carbendazim and dithiocarbamates which have been frequently detected in Europe in Vietnamese vegetables (but require specific methods to detect).

The basic information used for designing the sampling plan should be regularly updated and the monitoring plan should be refined based on the experience gained during pilot monitoring programme and other sources (e.g. findings of checks undertaken in importing countries). The principles of planning monitoring programme set out in this document can, and should, be applied for other commodities and for the whole country.

In addition to mango, it is recommended to subsequently introduce additional commodities of export importance as additional priority targets, with sampling and testing for residues in ≥ 114 samples per season. The results should be evaluated continuously, and the appropriate advisory actions should be taken immediately to limit the misuse of pesticides. For the 2023-24, the dragon fruits and chillie peppers are recommended as priority commodities, based on the observed

frequent violative residues detected in Vietnamese product by the European laboratories. Once the expectable residue distribution is established and the necessary corrective actions are taken, say after two years, additional priority commodities may be selected to obtain information on their expectable compliance level.

In order to enable evaluation of the results of the national monitoring programme (amounting to the order of 10th of millions), the residues measured in the selected commodities, the electronic processing of related data should be considered, and a suitable database be developed.

Violative results identified by the monitoring should be subject to rigorous follow-up, to identify root causes, with subsequent adjustment to the risk management approach to reduce or eliminate such occurrences in future. In line with the principle of transparency an annual residue monitoring report should be prepared and published and engaged scientists should be encouraged to publish their findings in refereed journals. **The publication of a report setting out the status of pesticide residues in Vietnamese produce (according to the well-established food safety principle of transparency) would provide a significant and positive step towards strengthening international confidence in Vietnam's pesticide management regime.**

2. Background and Introduction

2.1. Background

This report is produced by the Global Quality and Standards Programme (GQSP) in Vietnam: "Increasing quality and standards compliance capacity of Mango value chain in Mekong River Delta". The overall objective of the GQSP project is to enhance quality infrastructure at the local level to support compliance with food safety, quality, and sustainability standards in key export markets.

The project activities focus on compliance capacity of producers and exporters of mango in the Mekong River delta.

The mango sector, along with the horticultural sector in general, suffers from a number of compliance challenges, none more so that management of pesticide risks. There is clear *ad hoc* evidence of non-compliance based on testing of Vietnamese products in export markets. This has revealed examples of the use of unauthorised pesticides and concentrations of authorised ones in excess of Maximum Residue Levels (MRLs).

Vietnam did not contribute any information to a recent FAO study of the status of residue monitoring in the SE Asian region, nor participate in the associated workshops[1]. Vietnam has never designed and applied a scientifically structured (i.e. risk-based) sampling and testing exercise to determine the nature and extent of non-compliance. Such knowledge is the pre-requisite for risk management decisions e.g. to focus control resources on those compounds and locations which generate the greatest risks. The existence of a well-designed residue monitoring

[1] FAO. 2020. *FAO pesticide residue monitoring project for Association of South East Asian Nations (ASEAN) countries. Situation Assessment. Meeting report, 25 August 2020.* Bangkok.

programme is an essential foundation for improved controls and compliance with standards.

This report sets out, for the first time, a reasoned approach to the design of a residue monitoring programme for the determination of pesticide residues in Vietnamese mango. The programme is based on the principles of sampling statistics to ensure representativity, and the logistical and technical capacities of potential participating testing laboratories.

2.2. Introduction

The objectives of monitoring pesticide residues in raw agricultural commodities are to:

1. Verify their compliance with national and, in case of export, importing countries MRLs;
2. Provide preliminary background information on practical implementation of the Good Agriculture Practice (GAP) in the use of pesticides;
3. Identify pesticide crop combinations for which the established pre-harvest intervals may need to be reconsidered;
4. Indicate potential dietary intake problem which should be clarified independently with targeted sampling programme.

The project target is to pilot two export varieties (Cat Chu, and Cat Hoa Loc) in HCMC and Dong Thap Provinces. The whole main harvesting season as well as the out-season crops should be tested.

In view of the limited capacity of the project to arrange farm level sampling, it is recommended that the sampling would be performed in the packing houses, export warehouses and wholesale markets according to CAC Codex Sampling Guideline (CXG-033) instead of taking samples from the fields at the time of harvest.

The advantages of this arrangement are:

a) Providing fewer sampling points;
b) Avoiding the need for coordination of extensive field/farm visits;
c) Offering opportunity for gaining information on practices of packing houses regarding recording the origin of samples and the separate handling of individual lots (fruits produced by one farm), which form the basis of traceability systems.
d) The required quantity of targeted varieties of mango can be sampled (such information would not be readily available if the farms were randomly selected).
e) Crops grown in smaller producers (orchards <5 ha) would also be included in the sampling frame based on random selection, provided that the size of orchards are recorded by the packing houses upon receiving the fruits from farms (the PPD farm database only includes farms >5 ha).

The potential disadvantages are:

a) Limited or no information on the date, time and dosage of pesticide applications, or

preharvest Intervals (PHIs);

b) Products collected from intermediate traders may not have data on origin.

The climatic conditions vary among the growing areas and during the year, which may affect the pest pressure and require different plant protection activities leading to different level and kinds of pesticide residues. Therefore, the sampling of mango should cover the main harvesting season April to July (60% of production), and the reverse mango season August to February (40% of production) every year.

The experience gained with the pilot programme can be utilized for expanding the activities for the whole country and crops of economic importance.

3. Main principles of designing sampling plan

3.1. Number of samples to be collected

It is not practical to test each lot before placing the product on the local market or exported.

The key questions to be decided when the sampling/residue monitoring programme is planned are:

- How confident the government, (traders, exporters) want to be that the exported commodities would satisfy the importing countries pre-requisites;
- What is the level of compliance of plant protection practice with legal provisions, or from the other aspect are the current regulations suitable for promoting safe and efficient plant production meeting the market requirements;
- What laboratory capacity can be allocated (available) for reliable analysis of samples for pesticide residues?

There is no optimum number of samples to be taken. It depends on the selected probability to verify the compliance level of residues in individual commodities. The risk managers should decide on the acceptable violation rate, β_v, (i.e. the percentage of lots containing residues above the MRL) and the probability of finding such lots as part of the pre-export or market control.

In addition, to decide on the number of samples, the frequency of violation rate of pesticide residues, the production volume and value/quantity of exported commodities should be primarily considered. The consumption figures of the food items are of secondary importance, as the occasional moderate exceedance of MRLs does not cause health hazard for the consumers.

There are several methods of calculation of number of samples to be taken. However, most of them are only applicable for (assumed) normal distribution. Since we know that the distribution of pesticide residues is strongly skewed, it is recommended to apply the principle of binominal distribution for calculation of the number of samples to be analysed for verifying the targeted percentage compliance (tolerable violation rate) with specified probability level.

Let β_v be the probability that a random sample contains a residue above the allowed limit (e.g.

MRL). Then the proportion of samples at or below the selected limit, β_p, is 1-β_v. The number of random samples (n) required for finding at least one value above a selected percentile (βp) of the parent population (e.g. residues in samples taken from mango in a packing house) with a specified probability level (β_t) is calculated with the following equation:

$$\boxed{\beta_{t1} = 1 - \beta_p^n} \text{ or } \boxed{n = \frac{\lg(1-\beta_{t1})}{\lg\beta_p}} \text{ (equ.1)}$$

It is important to note that the above principle / equation provides correct information only if the following preconditions are satisfied:

- The sampling target is accurately defined, and all of its elements can be subject of sampling (e.g. all packing houses dealing with mango in the targeted pilot area are accounted for in advance);
- Before sampling starts at a given day the available individual lots in the packing house can be accessed and counted;
- The individual lots can be identified (lots are not mixed) and one composite sample represents one lot;
- The lots to be sampled are selected by drawing random numbers without replacement; that is one lot shall be sampled only once; it also means that the produce of the same farm shall not be sampled at the next sampling occasion, but may be sampled during different sampling period (main season, off-season);
- The export varieties (Cat Chu and Cat Hoa Loc) shall be sampled separately; their proportion shall preferably be decided based on their production volume;
- The number of lots to be sampled (N) during the sampling period is much larger than the number of samples (n) calculated with Equation 1.

The violation rate (β_v) is equal to 1-β_p. For example, the number of samples required for detecting a residue above a specified concentration at least in one sample at various violation rates is given in Table 1 for large N. The table indicates, if we target verifying that the 98% of our lots would comply with the MRLs of pesticide residues being in the samples with 95% probability we would need to analyse 149 samples. Moreover, if we would like to be 99% sure that no more than 2% of our lots contain residues above the MRL we should analyse 228 samples and detect residues exceeding the MRL only in one sample. Equation 1 can also be used to estimate the likely residue concentrations being in the selected percentile of the residues in crops grown in the area included in the sampling target. Such an estimate is very useful for assessing the potential compliance of tested products with the requirements of a target export market.

Table 1. Minimum number of samples *required to detect* at least one residue above the MRL at the selected violation rates (β_v) with pre-defined probability (β_t)

β_t [%]	80	90	95	98	99	99.9
β_v [%]	Number of samples to be taken					
0.1	1,609	2,302	2,995	3,911	4,603	6,905
1	161	230	299	390	459	688
2	80	114	**149**	194	228	342
2.5	64	91	119	155	182	273
5	32	45	59	77	90	135
10	16	22	29	38	44	66

The results obtained with the analysis of n samples can be interpreted and used in different ways.

If we took 149 random samples (table 1) from a population of mango with similar characteristics [e.g. the fruits were treated with pesticides according to the registered use patterns (dosage rate, pre-harvest interval etc.], and did not find residues above the maximum residue limits (MRL), we can state with 95% probability (in 95 cases out of 100) that less than 2% of mango lots would contain residues above the MRL. It means that the importer may find lots containing residues above the MRL in <2% of cases.

After completing the sampling programme, if a residue above the MRL was detected only in one sample, we can state with 95% probability, based on Equation 1, that no more than 2% of the produced fruits in the represented sampling target contains residues above the MRL.

However, if for a regular monitoring programme, we take 114 samples from each variety of mango and the distribution of residues are similar (statistically not different) in them, we may combine the residue data. In such case we can use the combined dataset (228) and conclude with 99% probability that no more than 2 % of the samples would contain residues above the second highest residue concentration detected.

If we have to verify compliance with an MRL in 99% of the lots with 99% confidence, then we have to plan to take random samples from 459 lots of mango (for instance).

The above conclusions are applicable separately for all pesticide residues determined in the samples taken from a commodity. Therefore, it is very important to include as many pesticide residues in the scope of the analyses of samples as methodically possible and report both the detected (<LOD) and non-detected residues.

The number of samples calculated with Equation 1 is independent from the number of lots (decision units) (N) of the same characteristics to be tested. For instance, crops treated according to use recommendations and grown in one growing season. However, the sampling plan should be prepared for each harvesting season independently because of the different seasons may require different pesticide application schedules for protecting the crops.

3.2. Guidance for deciding on βt and βv

It can be seen from table 1 that the number of samples to be taken and analysed rapidly increases, when seeking to verify low violation rates with increasing probability of detection. It is the *responsibility of the risk managers* to decide what level of control should be employed taking into account among other factors:

- The targeted compliance level (βp=1-βv) and probability (βt) of its verification,
- The results of preceding national monitoring and import control programmes,
- The risk that the owner of the commodity is willing to take when marketing a commodity containing residues above the MRL or the maximum acceptable residue concentration specified by the buyer (sometimes called 'private standard');
- Traceability records,
- The technical level of the crop production and protection; for instance, the estimated percentage of farmers:
    - Follow the use recommendations,
    - Get advice from trained agronomists,
    - Use calibrated sprayers,
    - Keep record of pesticide applications, which is presented together with the products offered for sale to packing houses.
- Availability and application of registered or authorized pesticides in good and constant quality verified by regular quality control. (If the pesticides are inferior quality, the growers may have to apply larger dosage then recommended to protect the crop, which results in high residues in the treated crops);
- The commitments of the growers to comply with use recommendation of pesticides, that is they grow their crops according to the principles of GAP,
- The laboratory capacity available and the performance characteristics of the methods applied comply with the minimum requirements.

3.3. Principles of applying stratified random sampling design

Since the elements of the sampling target are heterogeneous (e.g. different varieties, harvesting season, plant protection practice, capacity of packing houses) stratified random sampling would provide the basis for the best estimate of the compliance level of residues in mango (and any other) fruits.

The following part is given for **example**. The actual sampling plan and selection of sampling design should be decided based on the objectives of the programme as well as the financial resources, laboratory testing and sampling capacity.

3.3.1. Pilot study

The pilot study would be performed to gain initial information of the practical possibilities of sampling, sample handling, distribution and concentrations of residues and developing the suitable methods for testing all residues which are authorized to use in mango together with those which have been reported by RASFF.

Sampling locations: packing houses and wholesale markets located nearby the testing laboratories in HCMC and Dong Thap Province shall be identified, and their agreement be obtained for entering their premises and collecting the required information

Mango varieties to be sampled: Cat Chu and Cat Hoa Loc preferably in equal proportion if available. When one of the varieties is not available at the time of sampling, larger number should be selected from that one at the next occasion.

Number of samples: equal number samples should be collected from each variety at preferably equidistance intervals during the main harvest season (about 70-80) and 20-20 during the pre and post-harvest period.

Frequency of sampling: the objective of the pilot porgramme is to gain preliminary information the nature, concentration and distribution of residues, therefore the whole growing season should be covered. The economy of the implementation of the study should also be considered: thus 5-5 sample is recommended to be collected at one sampling time.

3.3.2. Full scale study

3.3.2.1. Capacity of packing houses

According to the latest information available from 2017, twenty-five packing houses operated in Dong Thap and 10 in Tien Giang provinces (Appendix 1). However, daily or annual capacity of packing houses in Dong Thap province was not reported. Moreover, the capacity of 8 packing houses in Tien Giang is very similar, while the outputs of three additional ones are much smaller (≤ 10%).

In addition, there are 24 exporters with packing and preservation facilities. Their annual output has not been reported.

Due to the limited information currently available, the mango in packing and exporting companies should be sampled with equal probability, except packing houses 50-52 which may be omitted from the pilot sampling programme because of their very low output.

During pilot sampling programme the currently missing information (e.g. production volumes, varieties) can possibly be collected, and the sampling plan can be refined for the following years.

3.3.2.2. Considering mango varieties

Since there is no information on the proportion of the annual production of Cat Chu, Taiwanese, and Cat Hoa Loc varieties, neither on their potential sensitivity for infection, these varieties should be sampled in equal proportion and probability during the first year of monitoring.

3.3.2.3. Variability of mango production along the growing season

Because of the lack of information on the quantity of harvested mango varieties during the main and off season, it is proposed, as a first approximation, to allocate 1/3rd and 2/3rd of the samples to be collected during the off-season and main season, respectively.

4. Pesticide residues to be included in the analyses of samples

Since there is no information on the residues detected previously in mango samples taken from the local market or shipments to be exported, and neither did the RASFF notifications indicate unauthorized residues in mango between 2012-2019, no guidance can be obtained from prior studies.

The residue analytical laboratories should validate or verify the performance of their methods concerning the list of pesticides authorized for use in mango in Vietnam (Appendix 2), MRLs being in force in the EU and USA and recommended by Codex (Appendix 3) and reported within the RASFF. (Appendix 2A). Special attention is recommended to be paid to carbendazim and dithiocarbamates which have been frequently detected in Europe in Vietnamese vegetables, although testing for these compounds requires specific analytical methods.

The laboratories should gradually expand the scope of their methods to cover all potentially present pesticide residues and apply rigorous internal quality control programme for continuously verifying the appropriate performance of their methods including Limit of Detection (LOD) values at or about 0.003 mg/kg for pesticide residues having MRLs of 0.01* mg/kg, which indicates no detectable residue can be present.

It should be borne in mind that if a laboratory validates its method at a Limit of Quantification (LOQ) of 0.01 mg/kg, the laboratory will be able to verify compliance with a 0.01 mg/kg MRL only in <50% of the cases, due to the uncertainty of laboratory measurements. As a result, non-compliant lots will be exported in spite of apparently compliant results from the laboratory test. The laboratories taking part in the monitoring programme should optimize their detection system to achieve the LOD values listed in Appendix 4, which were confirmed in an excellent recent publication by Vietnamese scientists (Appendix 5 (S2-4 tables).

VERIFICATION OF THE PERFORMANCE AND CAPABILITIES OF LABORATORIES INVOLVED IN THE PILOT MONITORING PROGRAMME:

Testing laboratories do not routinely test for all of the residues which are likely to be present in mango. The laboratories should update and expand the scope of their test methods and verify their performance for at least those residues which to be looked for in the samples. Based on the reports on the method performance tests, the laboratories to be involved in the pilot monitoring programme can be decided. Since it is very important for obtaining reliable and accurate results, after demonstrating method performance complying with international standards, these laboratories are recommended to take part in an interlaboratory comparison test before the monitoring programme commences. The declared performance criteria of the test can be verified by the successful participation in the inter-laboratory comparison tests.

5. Allocation of samples to the testing laboratories

Once the laboratories involved in the pilot monitoring programmes have been decided the sampling sites can be allocated minimising the distance between the laboratories and the sites.

Assuming that SPCTC and DOVETEC laboratories will perform the analysis of samples in approximately equal numbers, the allocation of sampling sites for each laboratory is given in Appendix 1.

The principle is that the burden of collecting the samples concerning the distance between the sampling site and the laboratory should be minimised for both laboratories. Since the sum of distance of SPCTC is much larger (~3500 km) to sampling sites than for DOVETEC (800 km), only the number of sampling occasions and the number of samples to be analysed can be equalized.

The sampling plan can be finalised after samples to be delivered to the testing laboratories will be agreed and fixed. Since the declared residue analytical testing capacity of DOVETEC is about 75% of SPCTC, much larger number of samples most likely cannot be allocated to DOVETEC.

The actual number of samples to be taken by the participating laboratories and the sampling sites may be somewhat different due to the random sampling procedure which would be applied (Appendix 6).

CAPACITY OF TESTING LABORATORIES:

The current capacity of the SPCTC and DOVETEC laboratories is about 800 and 600 samples per year, respectively. Assuming that they will take part in the implementation of the **pilot residue monitoring** programme and the recommended level of testing is accepted, the total number of samples to be analysed (228) would amount to about 15% of the current laboratory capacity, which seems to be an acceptable load. For the model sampling programme including three mango varieties 342 sample would be taken (25% of laboratory capacity).

6. Sampling and sample handling

Samples shall be taken according to TCVN 9017:2011 (Fresh fruits sampling method in the orchards) and TCVN 5102:1990 (Fresh Fruits and vegetables – Sampling) from individual lots with possibly identifiable origin. The relevant provisions of the standard shall be considered as appropriate.

Sample size is defied by the Codex Guideline CAC/GL 33-1999[2]: the laboratory sample must contain ≥ 5 pcs fruits and the mass of the fruits must be ≥ 2 kg. Healthy mango fruits (without visible infection) shall be selected from different positions of the lot. Where feasible, fruits should be selected before packing them in boxes, to avoid excessive handling.

The fruits shall be collected in heavy Polyethylene (PE) bag and placed in a Styrofoam box containing ice to keep the temperature below 15 °C but without being frozen. The samples should be transported to the laboratory by car without delay after completing the sampling record sheet (Appendix 7).

[2] Recommended Methods of Sampling for the Determination of Pesticide Residues for Compliance with MRLS, CAC/GL 33-1999

Sample should be stored in refrigerator at 4-6°C in the laboratory and processed as soon as possible.

7. Estimated cost of the monitoring programme

The cost calculation is made only for providing a rough estimate for the expectable expenses using the parameters of the targeted model monitoring programme.

The cost estimate for the pilot sampling program with different sampling plan and lower number of samples can only be made after the details of the sampling plan will be agreed and finalized.

Cost estimate of model monitoring programme:

Based on the guidance values provided by South Pesticide Control and Testing Centre

Total no. of samples = 400

No. of sampling locations = 52

1. Transport of samples

1.1. Options:

(a) One sample will be taken from each variety on each sampling day

58 sampling days: SPCTC: 2×8,052=16,104 km; DEVOTEC: 56 sampling day, 2×9,827=19,654 km (including return journey)

(b) Two lots are sampled from each variety at one sampling occasion and two packing houses situated in the same location are visited (altogether 3 ×2× 2 =12 samples per day)

SPCTC:29 sampling days 8,052 km; DEVOTEC: 28 sampling days, 9,827 km

1.2. Renting a car for transport of samples: about 7,700 VND/km
Assume sampling (b option):
8,052+9,827=17,897 km rounded 18,000 km = 138,600,000 VND

2. Local travel and stay

10 km between sampling sites 57 sampling days: 570*10=5,700 km about 34,400,000 VND

2.1. Hotel for overnight stay 15$/night/2 person 57 nights: 19,431,818 VDN

2.2. Meal allowance 3$/person/day: 7,772,727 VDN

3. Purchase of samples

342 × 2 kg× 60,000 VND= 41,040,000

4. Packing of samples

Estimated 3,525,000 VND

5. Performance verification

2 methods/laboratory: 31,501,000 ×2= 63,002,000 VND

6. Analysis of samples

3,530,000 VND/sample 342+50 recovery+8 system suitability test 400 sample= 1,412,000,000

7. Inter-laboratory comparison

2500000

8. Unexpected expenses, reserve

10%

9. Summary of estimated cost for sampling according to option (b):

Cost Item	**Cost**	**Contributor**
Transport and collection of samples[1]	138,600,000	To be determined
Local travel	3,400,000	To be determined
Meal allowancefor samplers	7,772,727	To be determined
Hotel for samplers	19,431,818	To be determined
Purchase of samples	41,040,000	To be determined
Packing material	3,525,000	To be determined
Performance verification of methods in two laboratories	126,004,000	To be determined
Analyses of samples[2]	1,412,000,000	To be determined
Preparation for Inter-laboratory comparison in 3 labs	2,500,000	To be determined
Performance verification 3rd lab	63,002,000	To be determined
Sub total	1,816,475,545	
Unexpected expenses, reserve 10%	181,647,555	To be determined
Grand total, VDN	**1,998,123,100**	
Grand total USD	**87,917**	
1 VND=0,000044 USD		

It should be noted that:

[1]This estimate excludes fees/salary for laboratory staff who will collect the samples

[2] Approximately 78% of the total cost is for analysis of samples, calculated at the listed prices set by MARD/MOST. **This over-estimates the additional cost of the testing which would be actually incurred by Ministry of Agriculture and Rural Development (MARD). Since the laboratories currently operated below their optimal capacity, the additional costs are limited to cost of purchase of reagents, standards and other consumables (columns etc).**

8. Interpretation and follow up of residue concentrations measured in samples

8.1. Sources of MRLs

Since only a limited number of pesticide residues have MRLs established by the Ministry of Health, the laboratories should check the Codex MRLs (http://www.fao.org/fao-who-codexalimentarius/codex-texts/dbs/pestres/pesticides/en/) and the targeted export market relevant regulations.

Appendices 3, 8 and 9 provide information for MRLs in mango and URL links for other commodity pesticide residue combinations.

8.2. Interpretation of results

Any sampling programme can only provide meaningful information if it is combined with comprehensive qualitative and quantitative determination of all residues that can be potentially present. Once the laboratories provide reliable information on the concentration distribution of detectable residues, and the list of residues which are not present in detectable concentration some important conclusions can be drawn from the results.

Provided that 114 random samples are taken from each mango variety, as recommended for the pilot sampling programme:

(a) One can state with 90% probability that no more than 2% of the mango lots grown in the sampled area contain higher residues than the maximum concentration determined in the samples.

(b) If an MRL is established for a pesticide residue and the measured highest residue is lower than that MRL, then it can be stated with 90% confidence that less than 2% of the mango lots may contain residues above the MRL.

(c) However, if one sample contains residue above the MRL, it indicates with 90% probability that no more than 2 % of the produced fruits in the represented sampling target contains residues above the MRL. That is, the importer may find violative residue in maximum 2 % of the extorted lots.

(d) If no sample contains residue above the LOD, it indicates with 90% probability that less than 2% of the cases were the tested pesticides applied in mango orchard.

(e) If the residue distributions in the two mango varieties tested are statistically not different, the results can be combined and the above statements can be made with 95% confidence.

8.3. Follow up investigations

Best international practices as expressed in a recent FAO report on pesticide residue monitoring in SE Asia[3]. This states that *"...members also recognize that a sound pesticide residue risk management framework does not only rely on residue monitoring, but also includes pesticide registration, chemical control-of-use, traceback investigation and a chemical review process".*

Therefore, all results of analysis on samples which are identified as being drawn from violative consignments should initiate a specific follow-up investigation. This should commence with an interview with the supplier of the sample.

In the case that this is a producer, then farm records of pesticide interventions should be characterised. This should seek to identify:

- Name of pesticide formulation
- Dosage dates and rates
- Harvest date
- Transaction data (to whom sold)

In the case that the supplier is a distributor or packhouse, this should additionally seek to identify:

- Name of any post-harvest treatment
- Dosage dates and rates
- Transaction data (from whom obtained and to whom sold)

The investigation may involve follow-up interviews with value chain actors and officials, examination of records and other documents, and even additional sampling and analysis. In all cases the objective should be to identify the circumstances which gave rise to the non-compliance. Examples could include the use of inappropriate or non-approved pesticides, incorrect dosage or application schedule or failure to apply suitable post-harvest interval.

The consultants recognise the current limitations of record keeping in the supply chain which limit the capacity to trace back consignments to the farm, and trace forward to the market other (unsampled) batches subject to the same non-compliance. However, improvements to the traceability system being promoted by the Government of Vietnam should ensure progressive reduction of these limitations.

The activities and findings of the investigation should be recorded in a written report. This should conclude with recommendations for strengthening the risk management system in a way which will reduce the probability of a similar situation arising in the future (for example, changes to

[3] FAO. 2020. *FAO pesticide residue monitoring project for Association of South East Asian Nations (ASEAN) countries. Situation Assessment. Meeting report, 25 August 2020.* Bangkok.

regulations, improved training, better communication on farm level use etc).

8.4. Annual residue monitoring report

It is recommended that the residue monitoring exercise and the consolidated results and outcomes should be written up in the form of a report on pesticide residues in the selected commodities. This should conclude with recommendations for changes in risk management approaches, thus strengthening continuously the regulatory framework and compliance. The publication of such an annual report (according to the well-established food safety principle of transparency) would provide a significant and positive towards strengthening international confidence in Vietnam's pesticide management regime. Additionally, the Plant Protection Department (PPD) could also encourage the scientists involved to publish their results in refereed journals.

A good model example of an annual residue monitoring report is provided by the European Food Safety Authority (EFSA) at:

National summary reports on pesticide residue analysis performed in 2018 - - 2020 - EFSA Supporting Publications - Wiley Online Library

https://efsa.onlinelibrary.wiley.com/doi/pdf/10.2903/sp.efsa.2020.EN-1814

As can readily be observed, such reports can easily be produced without compromising on the confidentiality of the providers of the samples and the laboratories concerned.

9. Recommendations

(a) A pesticide residue monitoring coordinator should be appointed within PPD who will:

(i) Finalize the sampling programme taking into account the currently available information;

(ii) Allocate sample number starting with PM001/year to identify the samples deriving from the pilot monitoring programme;

(iii) Finalise sample record forms based on model in Appendix 7

(iv) Follow up the implementation of sampling process, and

(v) Initiate the necessary corrective actions if necessary.

(b) In view of currently missing essential information for performing stratified random sampling design, based on the arguments put forward in section 3, simple random sampling with equal probability is recommended for each variety separately.

(c) Taking into account the capacity of the two targeted laboratories, in relation to mango, 114 random samples should be taken from each variety during the whole growing season (total number of samples is 228 or 342). That would provide information on the distribution of

residues in 98% of the marketed mango samples with 90% probability.

(d) It is assumed that the targeted varieties will be available in all sampling sites and can be sampled at the same time. However, it is permissible, with the agreement of the testing laboratory, to take 2 or 3 samples from each variety at one time if independent identifiable lots are available to reduce the cost of collection of samples. It may also be permissible without infringing the principle of random sampling, to take more than one sample from one variety, if another variety is not available, and collect more samples when it is possible.

(e) The sequence of sampling, based on random selection of sites is given in Appendix 6.

(f) This preliminary sampling plan should be refined when additional detailed information is going to be available before the pilot monitoring programme commences.

(g) The experience gained with the pilot monitoring programme for mango can be used to design national monitoring programme for other commodities.

(h) Persons performing sampling should receive training on principles of sampling and should be provided with official certificate authorizing them to enter the premises of packing houses/exporters and taking samples from randomly selected lots.

(i) The laboratories should gradually expand the scope of their methods to cover all potentially present pesticide residues and apply rigorous internal quality control programme for continuously verifying the appropriate performance of their methods including LOD values at or about 0.003 mg/kg for pesticide residues having MRLs of 0.01* mg/kg, which indicates no detectable residue can be present.

(j) The residues measured in the selected commodities together with the corresponding internal quality control data should be accessible, statistically evaluated and published.

(k) In order to enable evaluation of monitoring result, the electronic processing of related data should be considered in the future and a suitable database be developed.

(l) A risk management policy should be developed and applied which identifies violative results, based on pre-defined target levels of compliance desired by risk managers

(m) There should be developed a system of follow up in the field and throughout the supply chain of any violative results identified, and understanding of root causes determined, with relevant feedback in in terms of adjustments to the risk management approach

(n) An annual report on pesticide residues in Vietnamese fruit and vegetable should be prepared and published by the PPD of MARD, setting out the findings, nature and causes of non-compliance and actions taken.

Appendix 1. Identification numbers of sampling sites and laboratories taking the samples

ĐỒNG THÁP (Collectors) Id. number and name of sampling sites	Distance to (km)[1]		Sampling by	
	DOVETEC	SPCTC	DOVETEC	NAFQAD
1-Nguyễn Văn Có	25	131		x
2-Trần Hoàng Vân	25	131		x
3-HTX SX và Tiêu thụ Xoài	25	131		x
4-Đỗ Thị Ngọc Thơ (Triết)	25	131		x
5-Nguyễn Văn Hải	25	131		x
6-Phạm Thị Cẩm Vân (Yến)	25	131		x
7-Hồ Hữu Hạnh	25	131		x
8-Hữu Thi	25	131		x
9-Thanh Bình (Vũ chi)	25	131		x
10-Bảy Ly	25	131		x
11-Chính Vinh	25	131		x
12-Bình Thái	25	131		x
13-Tuấn Uyên	25	131		x
14-Liêm Soạn	25	131		x
15-Thùy Nghĩa	25	131		x
16-Tuấn Thủy	25	131		x
17-Hải Yến	25	131		x
18-Như Ý	25	131		x
19-Long Nhiên	25	131		x
20-Ngọc Tuấn	25	131		x
21-Hùng Tấn	25	131		x
22-Nguyễn Thị Kim Phượng	25	131		x
23-Đinh Tấn Sơn	25	131	x	
24-Nguyễn Thị Thu Ba	25	131	x	
25-Trần Thị Liễu	25	131	x	

ĐỒNG THÁP (Exporters) Id. number and name of sampling sites	Distance to (km)[1]		Sampling by	
	DOVETEC	SPCTC	DOVETEC	SPCTC
26-Cty TNHH Công nghệ thực phẩm Việt Đức	17	197	x	
27-Công ty TNHH Quang Vinh Food	28	208	x	
28-DNTN SXTM Nông sản Hùng Tấn	27	207	x	
29-Công ty TNHH MTV Nam Huy Đồng Tháp	57	237	x	
30-Tổ hợp tác sản xuất và dịch vụ Hiếu Phát	20	200	x	
31-Ngân Phát	22	202	x	
32 Công ty TNHH Kim Nhung Đồng Tháp	7	187	x	
33-Hộ kinh doanh Nguyễn Thanh Nhã	27	207	x	

ĐỒNG THÁP (Exporters) Id. number and name of sampling sites	Distance to (km)[1]		Sampling by	
	DOVETEC	SPCTC	DOVETEC	SPCTC
34-Công ty TNHH Nông sản Chú Chín	15	195	x	
35-HTX Xoài Mỹ Xương	13	193	x	
36-Vựa xoài Nhiều	13	193	x	
37-Nguyễn Văn Út	22	202	x	
38-CN Công ty TNHH TM CB NS TP Tuấn Đạt	8	188	x	
39-Cơ sở chế biến trái cây Việt Tuyền	15	195	x	
40-Kho chế biến nông sản Kiến Văn	20	200	x	
41-Công ty TNHH Rau quả Hùng Hậu	34	214	x	
42-Công ty TNHH MTV Nông sản Hồng Cúc	37	217	x	

TIỀN GIANG (Exporters) Id. number and name of sampling sites	Distance to (km)[1]		Sampling by	
	DOVETEC	SPCTC	DOVETEC	SPCTC
43 Chi nhánh Cty TNHH Long Uyên	75	145	x	
44. Công ty TNHH SX CB nông sản Cát Tường	70	150	x	
45. Công ty Cổ phần rau quả Tiền Giang	75	145	x	
46. Công ty TNHH MT	70	150	x	
47. Nhà máy chế biến - Công ty TNHH SX trái cây Hùng Phát	80	160	x	
48. Công ty TNHH sản xuất TMDV xuất nhập khẩu nông sản thực vật Hòa Lộc RR	125	115		x
49. HTX Hòa Lộc	125	115		x
50. Công ty TNHH MTV Sơn Thịnh Phát	75	145	x	
51. Công ty TNHH TMDV Bắc Mỹ Thuận	125	115		x
52. Công ty TNHH Nông sản Gấu Đôi	90	125		x

Appendix 2. List of active ingredients in plant protection products approved in Vietnam for use in mango

Extracted from: Annex 1: CIRCULAR (10/2019/TT-BNNPTNT)
ON PROMULGATING THE LIST OF PERMISSIBLE AND BANNED PLANT PROTECTION DRUGS IN VIETNAM

Insecticides	**Fungicides**	**Herbicide**
Abamectin	Ascorbic acid	Dalapon
Avermectin	Azoxystrobin	
Azadirachtin	Bismerthiazol	
Bacillus thuringiensis	Chitosan	
Bacillus thuringiensis var. kurstaki	Chlorothalonil	
Buprofezin	Citric acid	
Chlorflúazuron	Citrus oil	
Chlorpyrifos Methyl	Cytokinin	
Clothianidin	Cytosinpeptidemycin	
Dinotefuran	Fenbuconazole	
Emamectin benzoate	Folpet	
Liuyangmycin	Fosetyl-aluminium	
Matrine	Gentamicin sulfate	
Oxymatrine	Hexaconazole	
Petroleum oil	Humic acid	
Rotenone	Kasugamycin	
Saponin	Lactic acid	
Saponin acid	Mancozeb	
Saponozit	Mandipropamid	
Spinetoram	Ningnanmycin	
Spinosad	Oxytetracycline hydrochloride	
	Polyoxin	
	Propineb	
	Protein amylose	
	Streptomyces lydicus	
	Streptomycin sulfate	
	Sulfur	
	Tebuconazole	
	Tricyclazole	
	Trifloxystrobin	

Appendix 2A. Pesticide residues reported within EU RASFF in Vietnamese fruits and vegetables

Acephate	Ethion	Permethrin
Azoxystrobin	Diafenthiuron	Profenofos
Carbofuran	Dithiocarbamates	Propargite
Carbendazim	Fenpropathrin	Propiconazole
Chlorfenapyr	Fipronil	Pyraclostrobin
Chlorfluazuron	Hexaconazole	Quinalphos
Chlorpyrifos	Iprodione	Spirotetramat
Chlorothalonil	Methamidophos	Tricyclazole
Dimethoate	Phenthoate	

Appendix 3. Sequence of sampling at various sites[1]

	Identification number of sampling sites				
	Pre-season				
1	7	12	19	40	51
2	5	10	20	40	49
3	10	15	22	23	23
4	2	3	24	35	
	Main season				
1	27	39	39	47	47
2	4	6	9	22	34
3	2	47	6	26	2
4	20	27	29	38	43
5	4	9	4	23	26
6	33	14	20	33	13
7	15	26	29	44	45
8	9	12	14	25	30
9	8	16	27	37	46
10	5	27	29	30	46
11	2	7	9	18	41
12	10	30	45	46	46
13	23	24	32	42	52
14	14	21	23	23	50
15	2	4	45	6	36
	26				
	Post season				
1	12	14	15	32	52
4	2	13	37	39	45
3	6	27	46	48	50
4	26	28	29	36	

Note: [1]: Start sampling at the leftmost cell and proceed from left to right row by row

The starting date depends on readiness of laboratories to analyse the mango samples and the harvesting season.

Green colour pre and post season, yellow colour main season.

DOVETEC and SPCTC would take samples at 57 occasions if 3 samples are taken at each time. Number of visit can be reduced if more than 3 samples (one/variety) is taken.

The sampling coordinator should decide when the programme can be started.

Appendix 4. Sampling record sheet

Sample number: Date of sampling

Name of packing house/exporter:

Name of the representative of packing house:

Name of sampling officer: Name of Laboratory

Name of producer of the fruits:

Name and location of the farm/orchard:

Quantity of fruits taken:

Record of last two pesticide treatment:

Name of pesticide:

Date of treatment:

Dosage kg ai/ha:

Mode of application:

Date of harvest:

Comments:

Record:

- any information relevant for the interpretation of the results;
- quality of fruits;
- post-harvest protection technology applied

Any other observation

Appendix 5. ASEAN MRLs [mg/kg] for Mango

Pesticide	MRL (mg/kg)
Carbendazim	5
Cyhalothrin	0.2
Cypermethrin	0.7
Cypermethrin	0.7
Deltamethrin	0.2
Dichlorvos	0.1
Dimethoate	1
Dithiocarbamates	2
Fenvalerate	1
Imidacloprid	0.2
Profenofos	0.2
Propiconazole	0.05
Pyriproxyfen	0.02
Spinetoram	0.01
Triadimefon	0.05
Triadimenol	0.05
Carbaryl	3

Appendix 6. URLs for national MRL databases[1]

Agriculture

Pesticide maximum residue level legislation around the world

Find links to maximum residue level (MRL) legislation in many markets, including New Zealand, and to MRLs established by the Codex Alimentarius Commission (CAC).

Finding MRL requirements for destination markets

Most of the links in this table direct to external websites. Most of them are updated regularly. However, MPI does not guarantee the accuracy of the information. You should also check relevant trading partner legislation before exporting your plant products.

Links to MRLs and/or legislation

Country/market	Source	Notes
Argentina	SENASA Regulations InfoLEG Legislative documents	Select 'Resolucion' in 'Tipo de norma' and SENASA in ''Dependencia'. Select 'Busqueda: Por Texto', 'Resolucion' in 'Tipo de norma' and use 'LMR' in Text: search box.
Australia	FSANZ Food Standards Code Schedule 20	NZ MRLs also apply for NZ-produced food (TTMRA). MRLs are in Schedule 20.
Brazil	ANVISA Pesticide Monographs	MRLs included in the ANVISA pesticide "Monografias Autorizadas".
Canada	PMRA MRL Database PMRA Consultations	MRL Database (searchable). Proposed MRLs are the 'PMRL' series.
Chile	Chile Legislation	MRLs are in Resolution 581 (1999) – as updated by Chilean Ministry of Health.

Codex	http://www.fao.org/fao-who-codexalimentarius/codex-texts/dbs/pestres/pesticides/en/	MRL database (searchable).
Costa Rica	SFE MRL Webpage	MRLs are in RTCR 424-2008, as updated by SFE.
European Union	EU Pesticides Database EU MRL Legislation UK HSE Pesticides web page	EU database of pesticide MRLs and active substance authorisations (searchable). Regulation EC 396/2005 and amendments. Recently adopted and proposed EU MRLs (See 'News').
GCC	GSO Standards Store	A list of GCC Standards (available for purchase). Search for "maximum limits".
Hong Kong	CFS MRL Database	MRL Database (searchable).
India	FSSAI Legislation	MRLs are listed in the "Food Safety and Standards (Contaminants, Toxins and Residues) Regulation, 2011. (See Compendium for updates).
Indonesia	Indonesia E-Legislation website	Select 'Nomor' as search key and search for the "KR.040" set of regulations. MRLs currently in 55/Permentan/KR.040/11/2016.
Israel	MARD (PPIS) Data Bank	Select "Search" to access the Pesticide Residues database (searchable).
Japan	FFCR website	See "MRLs List" for a database of MRLs (searchable).
Korea	MFDS MRL database	MRL database (searchable). Also includes relevant Codex MRLs, and Import MRL information.
Malaysia	MOH FSQ Legislation	Select "Perundangan". MRLs are in the Food Regulations 1985, see the linked Schedules (Schedule 16).
New Caledonia	DAVAR Pesticides webpage	MRLs are listed in "La deliberation no. 113/CP du 18 Octobre 1996".
New Zealand	MRLs for agricultural compounds	MRLs are listed in "Food Notice: Maximum Residue Levels for Agricultural Compounds".
Philippines	BAFS website _no access	Use the PNS filter to select: 'Crops' > 'Fresh Fruits and Vegetables' > 'MRLs for various Fruits and Vegetables'

Russian Federation	Rospotrebnadzor legal texts Requirements for pesticides (EU webpage)	Search for document series '1.2.3111-13'
Singapore	AVA Legislation webpage no access	See Sale of Food Act and the 9th Schedule in the associated Food Regulations.
South Africa	GOV.ZA portal	Search for 'Foodstuffs pesticide'.
Switzerland	Federal Council portal	DFI MRL Ordinance (817 series).
Taiwan	FDA Laws & Regulations	See Standards for Pesticide Residue Limits in Foods.
Thailand	ACFS General Standards no access	Browse for '9002' document series.
USA	GPO Federal Digital System	MRLs are in e-CFR, Part 40, Section 180
Vietnam	Vietnam Law website Vietnam Law website – English version	Search Title for 'TT-BYT maximum residue'. An MoH Circular is available for purchase in English through this webpage.

Other links of relevance:

Link	Notes
ASEAN Standards and Guidelines	Includes a database of ASEAN MRLs
Australia NRS MRL Database	Searchable database of MRLs for Australia and some other countries for Australian-registered pesticides on selected foods, compiled by the National Residue Survey.
Global MRL database (Bryant Christie)	Searchable MRL database for a wide range of commodities, pesticides and countries. Free access to US MRLs, other country MRLs available by subscription.
USDA FAS Reports	USDA's Food and Agricultural Import Regulations and Standards (FAIRS) country reports and Exporters Guides.
WTO/SPS notifications (ePing)	A searchable database of WTO SPS and TBT notifications.

Last reviewed: 16 Nov 2020

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- See more contact details

NOTE:

Since the preparation of the report some of the website became unavailable.
No alternative access could be identified.

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